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THESIS

NO PROJECT EXISTS IN A VACUUM: ORGANIZATIONAL EFFECTS IN ENTERPRISE INFORMATION SYSTEM DEVELOPMENT

by

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13. ABSTRACT (maximum 200 words)

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This thesis focuses on the interplay of explicit and implicit organizational factors in complex organizations, and their effect on the outcome of IT projects. Through implicit organizational factors, a poorly executed, unhealthy project may infect healthy projects, similar to the spread of a contagion. This thesis utilizes a study of the United States Coast Guard WatchKeeper and Mission and Asset Scheduling Interface systems' development as an example of the contagion effect.

Analysis revealed three classes of implicit organizational factors that impacted project outcomes: capacity, control, and funding priorities. From an organizational perspective, implicit factors were found to play a much more significant role in affecting the outcome of projects than explicit factors. This is important because managers at various levels of hierarchy tend to focus only on explicit factors, often ignoring implicit factors. Several recommendations for improving project and portfolio management are presented based on this finding.

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NO PROJECT EXISTS IN A VACUUM: ORGANIZATIONAL EFFECTS IN ENTERPRISE INFORMATION SYSTEM DEVELOPMENT

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LIST OF ACRONYMS AND ABBREVIATIONS

ADE	acquisition decision event
ALMIS	Aviation Logistics Management Information System
AMT	Account Management Tool
AOPs	Abstract of Operations system
ATO	authority to operate
BFT	Blue Force Tracking
C3CEN	Command, Control, and Communications Engineering Center
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
C4IT	Command, Control, Communications, Computers and Information Technology
C4IT SC	C4IT Service Center
CG	Coast Guard
CGI	Conseillers en Gestion et Informatique
COI	critical operating issues
OSC CSD	OSC Customer Service Department
DAA	designated approving authority
DHS	Department of Homeland Security
DOD	Department of Defense
DOG	Deployable Operational Group
EOC	Executive Oversight Council
ECSS	Expeditionary Combat Support System
EDA	event driven architecture
ERP	enterprise resource planning
ESB	enterprise service bus
GAO	Government Accountability Office
HQ	headquarters
IMS	integrated master schedule
IOC	interagency operations center

IOP	interagency operational planning
IPT	integrated product team
IT	information technology
IVT	integrated vessel targeting
JCIDS	Joint Capabilities Integration and Development System
KPP	key performance parameters
MAIS	major automated information systems
MAGNet	Maritime Awareness Global Network
MASI	Mission and Asset Scheduling Interface
MDA	maritime domain awareness
MHS-Ops	Maritime Homeland Security Operations
MISLE	Marine Information for Safety and Law Enforcement
MNS	mission needs statement
MRTO	MASI requirements task order
MSAM	Major System Acquisition Manual
NAIS	Nationwide Automatic Identification System
OM	operations monitoring
OPAREA	operating area
ORD	Operational Requirements Document
OSC	Operations Systems Center
PM	program manager
PMBOK	project management body of knowledge
PMI	Project Management Institute
pORD	Preliminary Operational Requirements Document
SAFE Port	Security and Accountability for Every Port
SCC	sector command centers
SDLC	system development life cycle
SOA	service oriented architecture
TISCOM	Telecommunications and Information Systems Command
USCG	United States Coast Guard
WBS	work breakdown structure
WK	WatchKeeper

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I. INTRODUCTION

A. BACKGROUND

Investment in information technology (IT) programs has been identified as a critical area in the federal government. The federal IT Dashboard (2014) shows total fiscal year 2013 IT spending at nearly $76B for 28 agencies. In the Department of Homeland Security (DHS) alone, $5.6B was invested in 345 projects, with $4.5B for 91 major projects. From huge enterprise resource planning (ERP) systems potentially catering to hundreds of thousands of users, to small research systems with hundreds of users, successful IT development is critical to the functioning of organizations. In general, much of the IT development expense in the federal government involves transitioning from legacy silo systems to enterprise spanning systems which facilitate sharing of data and integration of IT with business processes at all levels (Ross, Weill, & Robertson, 2006). The success rate of such endeavors is low.

IT development is typically complex and difficult. In 1994 the Standish Group published the original chaos report which detailed only a 16 percent IT project success rate. While this rate has increased over the years, the potential for “other than successful results” remains uncomfortably high at 61 percent (Standish Group, 2013, p. 1). A recent example of IT project difficulty is the healthcare.gov website, which was intended to allow people to shop online for private health insurance. Although cost estimates vary wildly depending on the source, the contractor was awarded $93M (CGI Federal, 2011) to construct the site, which was essentially non-functional upon delivery. Due to the high profile nature of the failure, additional resources were immediately committed to rework the site. At this time an overall cost estimate is not available, but development obviously exceeded cost and schedule projections while delivering minimal functionality.

IT development and project management have been the subject of intense study for forty years, but consistent successful implementation remains elusive. This thesis focuses on the interplay of explicit and implicit organizational factors in complex organizations, and their effect on the outcome of IT projects. Through implicit organizational factors, a poorly executed, unhealthy project may infect healthy projects, similar to the spread of a contagion. This thesis utilizes a study of the United States Coast Guard WatchKeeper and Mission and Asset Scheduling Interface systems' development as an example of the contagion effect. Extensive, in-depth data was available due to personal involvement in the projects by the author.

Analysis revealed three classes of implicit organizational factors that impacted project outcomes: capacity, control, and funding priorities. From an organizational perspective, implicit factors were found to play a much more significant role in affecting the outcome of projects than explicit factors. This is important because managers at various levels of hierarchy tend to focus only on explicit factors, often ignoring implicit factors. Several recommendations for improving project and portfolio management are presented based on this finding.

B. PROBLEM AND PURPOSE

This thesis investigates how implicit and explicit organizational factors affect the success of IT projects within an enterprise portfolio and how contagion may be transmitted between projects. The U.S. government spends billions of dollars per year on IT programs which exceed schedule and budget constraints while delivering less than promised functionality and performance. Research exploring inter-portfolio effects may lead to better preparation, planning, and execution of IT projects, as well as reducing duplicative systems. Successful integration of enterprise IT systems and alignment with business processes is critical to overall mission success.

C. RESEARCH QUESTIONS

- How can development of interdependent enterprise IT systems be affected by shifting portfolio funding priorities and clan control?
- How are capacity issues recognized, and can they affect development of systems within an IT portfolio?
- Can the interaction between explicit and implicit organizational control factors affect enterprise IT system development within a portfolio?

D. BENEFITS AND LIMITATIONS OF RESEARCH

Enterprise system development is a complex and difficult area in which to succeed. Interoperable and networked systems continue to become more critical due to the amount of digitized data available for use. Development of new systems typically takes place in an IT environment comprised of various legacy systems, with varying degrees of peer connectivity. Creation of new systems invariably affects existing systems, or other systems in concurrent development. Investigation of organizational factors, their interdependencies, and contagion theory will provide useful insight to managers of IT development projects within enterprise portfolios as well as portfolio managers themselves. The study contributes evidence meaningful in capacity and control theory, as well as certain recommendations specific to the USCG. The thesis does not attempt to provide a simple, overt model which solves this incredibly complex problem. Indeed, the author’s point is that diligence and awareness at the portfolio level are critical in an attempt to minimize (or intelligently focus the effect of) implicit organizational factors. Direct applicability to all enterprise system development is not implied.

E. IT PROJECT SUCCESS

Overcoming the difficulties inherent in successful development of complex IT systems has become an industry. Much has been written about development methodologies, cost estimation, and project management. Given the high stakes which accompany financial commitments of this magnitude, varying definitions of

“success” have been created by the program manager trying to emphasize the positives in a challenged or essentially failed project.

A commonly cited example in the Department of Defense (DOD) community is the United States Air Force’s (USAF) Expeditionary Combat Support System (ECSS). Upon cancellation in late 2012, the system had been in development for seven years at a cost of over $1B, with negligible capability. In addition, the USAF estimated another $1.1B would be required in order to achieve one quarter of the functionality originally promised, with system delivery in 2020 (Government Accountability Office [GAO], 2013b; Reilly, 2012; USAF, 2012b). Following cancellation, Congress and industry experts alike wondered how a failure of this magnitude had been allowed to happen, and why it had not been cancelled earlier. When Robert Shofner, the Air Force’s program executive officer for business and enterprise systems was asked this question, he called that “speculative” (Reilly, 2012, p. 3). The GAO investigated several “Major Automated Information Systems [MAIS]” in a 2013 report. Although many contributing causes were outlined for incomplete or failed systems, the focus during challenged, multi-year developments hinged on redefining “success” and lowering expectations. In the “impact” section of the USAF statement on ECSS cancelation, they focus on the “success” of other systems, rather than the ECSS failure:

> ECSS was one part of our overall logistics transformation effort. Expeditionary Logistics for the 21st Century (eLog21) was the overarching transformation campaign to fundamentally change the way logistics is accomplished Air Force wide. Since the eLog21 campaign started in 2003, numerous logistics and supply chain initiatives have been successfully implemented to improve AF processes, policies, and technology. To name a few examples, we leveraged Item Unique Identification marking process to cleanse 1.4M records within the Air Force Equipment Management System to better support Asset Marking and Tracking. In addition, we developed standardized processes and tools for implementing proactive engineering concepts to improve Weapon System Sustainment. Finally, we developed and implemented the Aircraft Availability Improvement Program. The [US]AF has ongoing initiatives to continue to transform AF wide logistics planning,

> resources and repair planning, data accuracy, centralized assessment management, and predictive maintenance. Despite the cancellation of ECSS, the AF remains committed and will continue to transform our logistics business processes. (USAF, 2012a, p. 1)

The statement above nearly portrayed ECSS as an incidental and noncritical portion of a larger effort, despite representing a $1B waste of funds.

Even the Navy ERP system, which is often hailed as a “success,” was delivered late, over budget, and with a functional subset much less than originally conceived. According to Perera:

> When measured against its original baseline, the lifecycle cost of Navy ERP has grown by about 31 percent as of September 2012, to $2.6 billion. It is also 2 years behind--auditors attribute slippages to system performance problems and the emergence of unanticipated requirements. The GAO also notes that as of December 2012, Navy officials reported that 560 system defects remained unresolved. (2013, p. 1)

While the above facts could be interpreted as “other than successful,” the Navy and those in charge of program development frame the program as a “qualified success”: “Since 2006, ERP costs have stabilized and the program has been successfully implemented at three SYSCOMs [system commands]” (RAND, 2012, p. 16). The Navy notes the ERP program promotes fiscal responsibility “while significantly reducing the cost of doing business” through standardization of business processes and common data sets (U.S. Navy [USN], 2014, p. 1).

With such a wide and variable definition of “success” in IT project development, a common framework is helpful in attempting to categorize project results while removing the human desire to avoid acknowledging negative results. This thesis follows the widely utilized categories put forth by the Standish Group:

- Resolution Type 1, or project success: The project is completed on-time and on-budget, with all features and functions as initially specified. (1995, p. 2)

- Resolution Type 2, or project challenged: The project is completed and operational but over-budget, over the time estimate, and offers fewer features and functions than originally specified. (1995, p. 2)
- Resolution Type 3, or project impaired: The project is cancelled at some point during the development cycle. (1995, p. 2)

Although challenges to the Standish categories exist, and alternate definitions have been presented, the Standish definition is sufficient for the purposes of this thesis. Under this classification system, WK would be rated as resolution type two, while MASI could be argued as either type two or type three.

F. METHODOLOGY PART I—OVERVIEW

This qualitative study utilizes a grounded theory and case study approach. According to Cresswell, grounded theory is a process which "involves using multiple stages of data collection and the refinement and interrelationship of categories of information" (2009, p. 13). The case study involves the in-depth exploration of "a program, event, activity, process" and is "bounded by time and activity" (Cresswell, 2009, p. 13). Extensive detailed information was collected by a participant observer during the case time-frame to include hundreds of files, emails, and design documents. The participant's placement within the case study program afforded unique personal insight and access to materials. An open coding scheme was utilized to generate information categories, and selective coding was used to explain the "story from the interconnection of these categories" (Cresswell, 2009, p. 184). Rather than beginning with a theory, hypotheses were allowed to emerge from the study (Oorschot, Akkermans, Sengupta, & Wassenhove, 2013).

Validity is supported through the use of multiple strategies (Cresswell, 2009). Triangulation involves utilizing "different data sources of information by examining evidence from the sources and using it to build coherent justification for themes" (Cresswell, 2009, p. 191). In this study, event analysis, analysis of archival data, and extensive data collected by the participant observer were utilized to enable triangulation. In addition to triangulation, a narrative description

was utilized to clarify complex sequences of events. The participant bias was clarified and the author was in the field with involved individuals during the majority of the program duration. As a final measure, member checking was utilized in critical areas. From the study and the analysis, and in line with the grounded theory approach, several themes emerged which are discussed in detail.

The organizational structure of the thesis separates and simplifies the study and results. Chapter II explores relevant related academic theory and studies, forming a strong platform upon which to base the analysis. Chapter III presents CG specific background information which enables understanding of later narratives. The complex CG hierarchical and directorate structure is explained, as well as CG acquisition and IT development procedures. The final section of Chapter III details the analysis methodology and validity support. Chapter IV contains the case study analysis using the framework of Chapter II as a lens, and references the important detailed events described in Appendix A. Chapter V summarizes the results, provides insight into possible solutions, and details further research opportunities.

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II. CONCEPTUAL FRAMEWORK (LITERATURE REVIEW)

A. ENTERPRISE IT SYSTEMS PORTFOLIO

1. Rationale for Enterprise IT

Successful complex organizations rely heavily on enterprise systems to make them “better, faster, and more profitable at what they [do]” (Ross et al., 2006, p. vii). Chen, Sun, Helms, and Jih note that managing an IT portfolio “can be conceptualized as an issue of aligning organizations with their IT to gain competitive advantages” (2008, p. 366; Reich & Benbasat, 2000). Gronau and Rohloff point out the “necessity of adjustment for information systems according to organizational environment” (2008, p. 1077) is critical because both business strategies and technology continually evolve (Luftman, 2003). When organizational goals or priorities change, the enterprise architecture vision and IT systems must align to the new processes, or disconnects occur between the operation of the organization and the critical support provided by the enterprise systems. If the IT systems are too difficult to change, organization processes may require modification to align to the systems. Ross et al., define enterprise architecture as “the organizing logic for business processes and IT infrastructure reflecting the integration and standardization requirements of the company’s operating model” (2006, p. 47). An organization’s operating model determines the key focus of IT initiatives, but the “key to effective enterprise architecture is to identify the processes, data, technologies, and customer interfaces” (Ross et al., 2006, p. 47).

Enterprise architecture is a broad area, and several books have been written on the topic. The discussion here does not address enterprise architecture and how to implement it, but rather a common side effect of an initial lack of enterprise thinking when developing IT solutions. The lack of enterprise thinking and resulting IT systems eventually limit business agility and growth. Many businesses and agencies fell into this trap organically, including the USCG,

which will be used as an example. The trap is the creation of IT silos, or isolated IT solutions within an organization. An IT silo refers to a system designed to meet a specific local business need. The problem occurs when the business later realizes their execution is limited by the lack of system interoperability. Ross et al. describe the situation: “Individually, the applications work fine. Together, they hinder companies’ efforts to coordinate…and the company’s data, one of its most important assets, is patchy, error-prone, and not up to date” (2006, p. 6–7).

The USCG traces its roots to the Revenue Cutter Service, formed in 1790. In 1915, the United States Life-Saving Service merged with the Revenue Cutter Service to create the Coast Guard. In 1939, the United States Lighthouse Service also merged with the USCG as well as the Bureau of Marine Inspection and Navigation in 1942. At various points during its history, the CG has been placed under the Department of the Treasury (1790), the Department of Transportation (DOT) (1967), and in 2003 was placed under the Department of Homeland Security (DHS) (USCG Historian’s Office, n.d.). Even with paper records and methods prior to the computer era, the CG was a mix of merged entities under several different agencies. Business processes were created and optimized at local levels, or within individual business units. During its tenure under the DOT, information systems became prevalent as well as networks and the World Wide Web. Certainly the switch to management under DHS took place when the CG had numerous IT systems in place. Is it any wonder IT systems were created which are unable to communicate with each other or share data?

In complicated environments with many siloed systems, direct database to database and direct system connections are often created one at a time, for valid reasons, until they are unmanageable as a group. This undesirable method leads to a web of interconnections where a change to a single system can force changes to all connected systems, or result in system failure when an interconnection goes unnoticed. Eventually, management of the tangled systems is no longer practical. Many businesses have found themselves considering

overarching enterprise architecture after realizing their legacy systems are inadequate and unsustainable in view of current business demands.

2. Interconnection of Enterprise Systems

Enterprise IT systems often share, access, or modify the same data. Certain enterprise systems may be considered the “system of record,” or the “authority” for specific data, which is then shared with other systems. According to Marechaux, “Today's business applications rarely live in isolation. They need to be connected in order to create an integrated solution from which an organization can derive value” (2006, p. 1).

A popular method for facilitating data sharing and interaction of enterprise systems is use of an enterprise service bus (ESB) which combines the virtues of service-oriented architecture (SOA) and event-driven architecture (EDA). SOA has become widely advocated as an enabler of business agility and as a tool to increase alignment of business goals and IT (Bieberstein, Bose, Fiammante, Jones & Shah, 2006; Chen, Kazman, & Perry, 2010; Choi, Nazareth, & Hemant, 2013). As previously mentioned, many organizations have legacy information system silos. Enterprise IT architecture favors process driven enterprise tools over function driven silos. SOA supports this method, as shown in Figure 1.

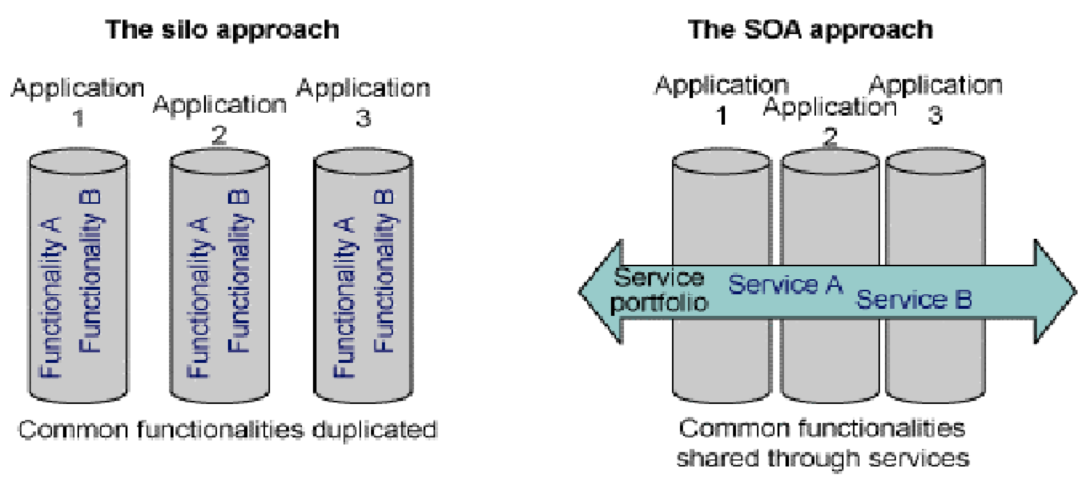

Figure 1. Silo versus SOA (from Marechaux, 2006)

EDA complements SOA. While SOA operates using a request/reply mechanism, EDA utilizes an asynchronous publish/subscribe method. By combining the two concepts the ESB allows for a wide range of communications between systems. SOA enables one-to-one connections, while EDA allows one-to-many or many-to-many publications. Applications within the portfolio publish services which other applications consume. Some systems accept write-backs from other systems or users. According to Marechaux,

> SOA is an architectural concept in which all functions, or services, are defined using a description language and where their interfaces are discoverable over a network. The interface is defined in a neutral manner that is independent of the hardware platform, the operating system, and the programming language in which the service is implemented. (2006, p. 1)

The technology independent service provided by one system may be subscribed to by any other system with the authority to do so. The same service may be consumed by multiple enterprise systems. The technology independent service, referred to as “loosely coupled,” eliminates the need for a direct connection to every system sharing data. Alterations may be made to the underlying system without affecting the published service. In this manner, changes to the system of record are transparent to systems consuming the data.

The USCG utilizes the ESB exclusively for all new connections between IT systems. As legacy systems are updated, direct system interconnections are eliminated in favor of ESB topics.

B. ENTERPRISE SYSTEM DEVELOPMENT WITHIN PORTFOLIOS

1. Overview

The Project Management Institute (PMI) discusses the relationship between projects, programs, and portfolios:

> A portfolio refers to a collection of projects or programs and other work that are grouped together to facilitate effective management of

> that work to meet strategic business objectives. The projects or programs of the portfolio may not necessarily be interdependent or directly related. (PMI, 2008, p. 8)

A program is “a group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually” (PMI, 2008, p. 9). Thus a portfolio encompasses programs which encompass projects, placing projects at the lowest level of this hierarchy. Not all projects are a member of a program, but all programs have subordinate projects. Management at the portfolio level is concerned with attaining strategic business goals, aligning efforts with organizational strategies, and proper resource allocation. Critical to the program definition is the requirement that member projects are “related through [a] common outcome or collective capability. If the relationship between projects is only that of a shared client, seller, technology, or resource, the effort should be managed as a portfolio of projects rather than as a program” (PMI, 2008, p.10). Unfortunately, in practice this clear hierarchy and line of authority from portfolio to project is not always present.

2. Resource Concerns

Central to the idea of enterprise architecture and IT is a well thought out high level view of a business and its needs. In avoiding or eliminating IT silos in favor of process oriented enterprise solutions, the overall IT portfolio must be considered. Even if enterprise systems within the IT portfolio of a business do not logically interact, they affect one another by their funding and resource requirements. In order to complete a major upgrade of one system, a different system may be required to subsist for the year on minimal funding and support. Gronau and Rohloff explain, “From the position of the value within the portfolio, recommendations for future arrangement of the IT strategy are derived” (2008, p.1077). No enterprise system exists in a vacuum and the portfolio view must be managed to prevent duplication of effort and ensure responsible expenditure of funds, as well as an overall balance of systems.

3. Interdependent System Development Complexities

In addition to resource concerns, enterprise system interactions must be considered at the portfolio level, preferably during system design and requirements gathering phases. By avoiding duplication of effort, the likelihood systems will share data, or operate on common data, is increased.

For systems under concurrent development, difficulties are encountered when attempting to coordinate development schedules between separate enterprise systems. No master schedule encompassing the projects exists because the projects are otherwise independent. Although the goal is to loosely couple systems via constructs such as the ESB, systems must articulate their data requirements to one another. If these requirements have been recognized at the portfolio level during the early stages of design, the effort can easily be scoped into the respective project plans. If the need is recognized in later stages, creation of unplanned ESB topics can force schedule slippage. In large organizations, a change review board, or other authority, must authorize changes to a project's functionality and schedule. Often, these enterprise systems have separate review boards with differing priorities. It can be challenging to compel another program's board to consider the needs of your program. Furthermore, for unplanned work, the other system may require you to supply funding for the effort. Practically speaking, schedules rarely align, requiring effort by management at organizational levels above those of the projects themselves. Organizational factors will then determine work priority.

C. DEVELOPMENT OF COMPLEX SOFTWARE SYSTEMS

1. Overview

Design and development of complex software systems involves actors at all levels of an organization. General discussion in this thesis is limited to enterprise systems development within large organizations, where stakeholders may or may not be internal to the organization, but they are distinct from the business entities responsible for project development. Furthermore, the focus of

discussion is the portfolio, program, or organizational view, rather than the project as an independent entity. Envisioning the portfolio in which a project is developed as a series of concentric rings is helpful in illustrating variables influencing single project development (Figure 2).

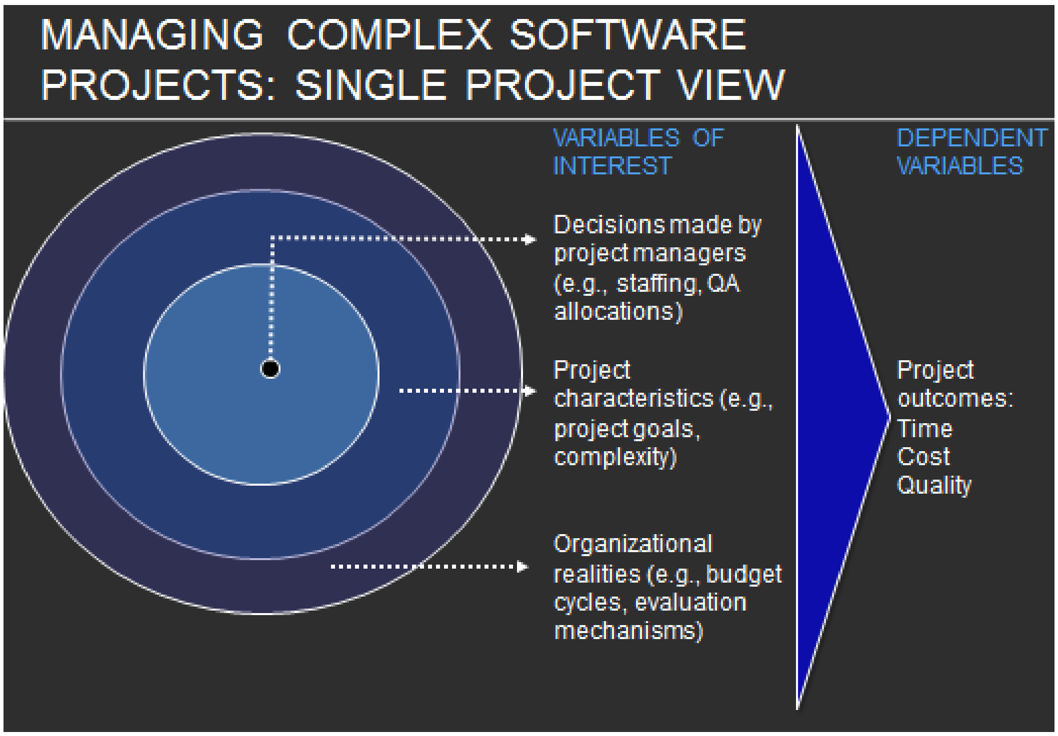

Figure 2. Managing Complex Software Projects: Single Project View

The project is affected by project manager decisions, its own characteristics, and organizational factors (Oorschot et al., 2013). Of specific interest is the interaction of the organizational realities ring with the other variables, and how the development and performance of other enterprise systems within the portfolio can affect other projects. Figure 3 illustrates how multiple projects often interact with each other, all affected by organizational realities. Large organizations may have hundreds of projects within an enterprise portfolio. A high level overview of each ring is provided in order to create a framework for analyzing interaction between variables.

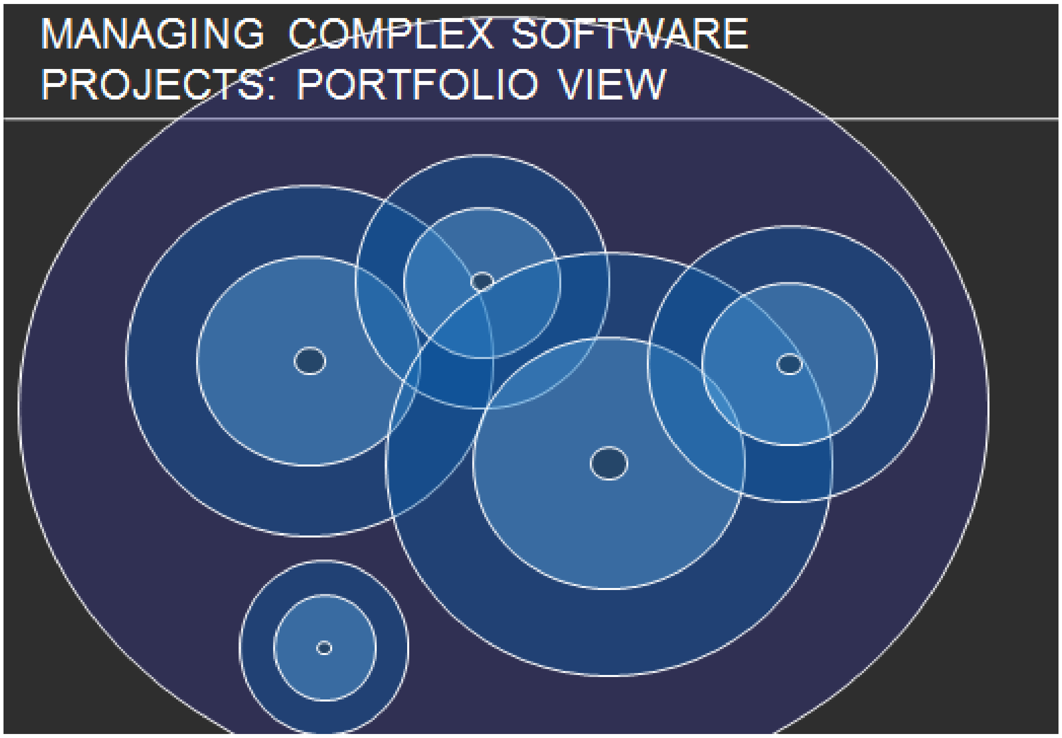

Figure 3. Managing Complex Software Projects: Portfolio View

2. Project Manager Decision Space

Although other factors also affect the success or failure of IT projects, Verner, Sampson, and Cerpa (2008), and Nelson (2007) agree project management plays a critical role. Nelson states, "After studying the infamous failures…it becomes apparent that failure is seldom a result of chance. Instead, it is rooted in one, or a series of, misstep(s) by project managers" (2007, p. 67).

The role of the project manager is well defined in the project management body of knowledge (PMBOK) as established by the PMI. A project manager has responsibilities to both the internal team and external organization (Satzinger, Jackson, & Bird, 2009).

3. Project Characteristics

Characteristics of the project itself are straightforward, though not always correctly identified early in the design process. As defined by the PMI, a "project is a temporary endeavor undertaken to create a unique product, service, or

result" (2008, p. 5). In the enterprise information systems context, projects typically require hardware, software, and network infrastructure. Depending on complexity, project duration may range from several weeks to several years, costing from thousands to billions of dollars. The magnitude and complexity of a proposed system also impacts time required for development. The goals or expected functionality of the information system are represented here. A common construct describes the relation of project characteristics with other factors. The construct, with small variation, is referred to as the Golden Triangle (Gardiner & Stewart, 2000), the Iron Triangle (Atkinson, Crawford, & Ward, 2006) or the Triple Constraint (Schwalbe, 2006) and one representation is shown in Figure 4. In this representation, quality is implied by the interaction of the three sides of the triangle. In other representations, quality may be placed on a side, with cost in the middle. Time and cost are self-explanatory, and scope refers to the desired functionality of the system. Although this representation is very simplistic, it reinforces the idea that only two of the three sides may be altered at any one time, with the impact of alterations shown in the third side. If schedule time and cost are reduced, the scope of the project must decrease. If increased scope is desired while holding schedule time constant, cost will increase (due to expanding the development team, etc.). It should be noted that although alterations to one side or another may be desired, the alteration may not be possible for the organization to implement due to capacity constraints.

Figure 4. Project Management Triangle (from Tutorialspoint, n.d.)

4. Organizational Realities (Factors)

Organizational factors permeate and influence every project as well as the higher portfolio. Ross notes, "The policies and technical choices for developing IT capabilities must reflect organizational realities and thus inevitably require tradeoffs" (2003, p. 3). True alignment of business and IT objectives is difficult to achieve, as indicated by Sjøberg, Odberg, and Warlo:

> Large private enterprises and government agencies generally have a comprehensive portfolio of interdependent information systems. A major challenge faced by these organizations is how to control the increasing complexity and the associated costs of such systems as the portfolio evolves. Typically, the number and size of the systems and the components of the individual systems increases over time, as well as the number of relationships between these systems and components. The continuous change in the nature of the business and often the increased complexity of the domain lead to more complex system requirements and information models, and the increased functionality of the systems. (2010, p. 71)

Even when business and IT objectives finally align, the business itself changes, or the information systems require increased functionality or replacement of outdated technology standards with current ones in order to maintain compatibility with other networked systems. As mentioned in the "Rationale for Enterprise IT," and supported by Ross, "The objective is to get to the point where

IT capabilities shape business strategy while business strategy shapes IT capabilities in response to changing market conditions and organizational realities” (2003, p. 3).

D. TYING IT ALL TOGETHER: ORGANIZATIONAL FACTOR INTERDEPENDENCIES

1. Overview

As introduced above, organizational factors are dynamic and shape the environment within which IT portfolio development takes place. This concept will be thoroughly explored because it is central to understanding the effect programs and projects may have upon one another within a portfolio. Organizational factors can be described as either explicit or implicit (Oorschot et al., 2013).

2. Explicit Factors

Explicit organizational factors are typically directly stated in a formal business plan, goal, or vision statement. They are also stated in official policies, standard operating procedures, and guidelines. IT system projects based on explicit organizational factors may be in response to the competitive advantage of another company, or created in an effort to gain competitive advantage. Legal and government regulations and budgetary constraints are explicit factors. Explicit measurements for IT systems include net present value, internal rate of return, and economic value added. If systems are expected to generate profits, explicit factors may include marketing, sales, and profitability factors. In other cases, the system may indirectly support the business, such as human resources systems, customer databases, and ecommerce systems. The ecommerce system, for example, does not increase sales directly, but enables sales over the internet in order to broaden the company’s potential customer base.

According to PMI, “Organizational structure is an enterprise environmental factor which can affect the availability of resources and influence how projects are conducted. Organizational structures range from functional to projectized, with a variety of matrix structures between them” (2008, p. 28). Organizational

structure delineates explicit lines of authority for programs and projects. A functional organization is the traditional hierarchical representation where employees have one superior, and departments are organized by function under a functional manager or vice president. Examples of functional departments are human resources, production, engineering, etc. Departments typically work independently of each other. In a matrixed structure, an employee will often report to both a functional manager and a project manager. The employee is assigned to work on a project but is still “owned” by the functional manager. If a project has no work for the employee on a given day the functional manager can reassign them as needed. A truly project-oriented structure grants the project manager a great deal of authority, but can be inefficient. In this model, the project manager has a diverse staff assigned to them for the duration of the project. The project funds the staff, regardless of whether there is immediate work to be done by a particular member (Schwalbe, 2006). Table 1 summarizes the project characteristics associated with the different organization structures.

Organization Structure / Project Characteristics	*Functional*	*Matrix*			*Projectized*
		Weak Matrix	**Balanced Matrix**	**Strong Matrix**	
Project Manager's Authority	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Resource Availability	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Who controls the project budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Manager's Role	Part-time	Part-time	Full-time	Full-time	Full-time
Project Management Administrative Staff	Part-time	Part-time	Part-time	Full-time	Full-time

Table 1. Organizational Influences on Projects (from PMI, 2008, p. 28)

3. Implicit Factors

As addressed here, implicit means “implied, rather than expressly stated” (dictionary.com, n.d.). Due to their nature, implicit factors may not be apparent, depend on individual interpretation, and can be dynamic. Prior literature has demonstrated that implicit factors can have a significant effect on the implementation and success of IT projects. A synthesis of the literature on information systems project management, and management of research and design organization portfolios, reveals three primary themes in the category of implicit factors:

- Capacity
- Control
- Funding Priorities

The three implicit factor areas are explored in-depth in the following sections.

a. Capacity

Capacity refers to the ability of an organization to complete work. At full capacity an organization has exactly the appropriate personnel and resources available to perform all work, according to the various program and project schedules. In reality, the operation of a large organization is too dynamic to attain or maintain full capacity in this sense. Chuan and Raghavan state, “Conflicting resource constraints between departments translate into business risk” (2004, pp 21). Capacity and funding priorities are similar in that they truly become the object of scrutiny when there are insufficient resources to complete all work. If too much work has been accepted, or capacity has been reduced due to turnover, reduction (or lack) of funds, or other loss of resources, the programs and projects within a portfolio will be prioritized.

Capacity can be visible, or hidden. An example of visible capacity is seen in the airline industry. The airline knows the explicit capacity of an airplane, and chooses to overbook the flight. They know how many people check in for the flight, and before boarding takes place, they know if the plane has exceeded

capacity. In this event, they offer incentives to reduce the number of passengers to that which the plane can carry. The industry has determined this approach to be the most cost effective in the long run, and the process is deliberate. Unfortunately, businesses with large IT portfolios engaging in complex system development have no such method to gauge excess capacity. It is hidden in the sense that it cannot be objectively determined at an arbitrarily chosen point in time. In system development, the concept of exceeding capacity is associated with elongating schedules, increasing cost, and personnel issues. As Sjøberg et al., note, “The greater complexity of the software portfolio leads to a higher cost of developing new systems and maintaining existing ones, a reduced business agility, a longer time-to-market, and an increased dependence on highly skilled people” (2010, p. 71).

Adding to the uncertainty of the capacity issue is the desire of many organizations to optimize operations through the elimination of organizational slack. Bourgeois defined organizational slack as

> …that cushion of actual or potential resources which allows an organization to adapt successfully to internal pressures for adjustment or to external pressures for change in policy as well as to initiate changes in strategy with respect to the external environment. (1981, p. 30)

Bourgeois argued that although cutting apparent organizational slack could achieve short-term efficiency, it was detrimental over time (1981). Keegan and Turner present the opposing view: “Opponents of slack claim that it promotes undisciplined investment in new developments and new products and services that show poor potential to generate economic benefits” (2002, p. 369). As mentioned, however, in the context of complex IT portfolio development and management, excess capacity is dynamic and difficult to quantify. From a personnel perspective, in a project-based firm it is not practical to lay off skilled developers following project completion, expecting they will return to the company for the next project. In a matrix based organization, one project may reserve a specialist who is reassigned to a higher priority project at the last

moment, jeopardizing the schedule of the original project. For a company attempting slack minimization, Goncalves, Mendes, and Resende note “the allocation of scarce resources then becomes a major objective of the problem and several compromises have to be made to solve the problem to the desired level of near-optimality” (2004, p. 1171). Put another way, projects in the portfolio may suffer due to excessive focus on slack minimization.

A common capacity problem often seen in businesses which have minimized organizational slack is firefighting. In the IT portfolio context, the more complex a system development project is, the more likely it will experience unforeseen problems (Sjøberg et al., 2010). A “fire” results when a project experiences such a problem, requiring assistance from resources external to the team. In the “optimized” organization, external resources must be pulled from other teams, thereby putting their project schedules at risk. This, in turn, may cause a “fire” in that project, and the process propagates. Programs of sufficient size may experience local firefighting within the program, as one sub-team cannibalizes another. The immediate effects of firefighting are many:

> Firefighting imposes numerous costs…Introduction dates are often slipped, reducing the chance of market success; engineers and managers sometimes work extraordinary hours, leading to fatigue, burnout, turnover, and increasing the chance of further errors; and additional people are often added to the project, thus requiring additional expense. (Repenning, 2001, p. 286)

From the portfolio management perspective, firefighting is a self-propagating cycle (Bohn & Jaikumar, 2000; Repenning, 2001).

Bohn and Jaikumar feel firefighting is best described as a syndrome, comprised of the following linked elements (2000, p. 4):

- Too many problems, not enough time to solve them all.
- Incomplete solutions
- Recurring and cascading problems
- Urgency supersedes importance

- Preemption of one problem solving effort by another
- Performance drop

Concerning the elements, they note: “We consider any organization that exhibits three or more of these elements to be doing firefighting, and if they are chronic it has the firefighting syndrome” (Bohn & Jaikumar, 2000, p. 5). In such an environment, a fundamentally troubled project may be misinterpreted as simply having capacity issues. An otherwise healthy project may be perceived as problematic due to the symptoms of firefighting without an understanding of the true cause. They describe the self-propagating nature of the syndrome:

> …there is a significantly worse situation that applies to many organizations, especially those where problem solving is inherently difficult. In these cases, the pressure of a backlog of unsolved problems leads engineers to solve problems not just inefficiently, but badly. As a result, each problem supposedly solved has a chance of creating a new problem, and sometimes more than one. (Bohn & Jaikumar, 2000, p. 16)

When this happens, projects become more susceptible to contagion from other programs within the portfolio.

b. Control

In complex organizations, control may be wielded by individuals or groups at varying levels of hierarchy. At higher levels, controllers influence IT architecture, organizational goals and portfolio strategy. At the middle level, controllers influence project development schedules, distribution of project funds, and prioritization. Lower levels control system quality and implementation. Controllers may or may not be explicitly designated and may have individual interests in certain programs or projects. Implicit control brokers may be informal advisors to explicit decision makers, or may have influence for a variety of reasons including interpersonal relationships, rank, or previous position within the organization.

Much of the research in organizational control theory is based on the work of Ouchi and extended by others, prominently Laurie Kirsch and various collaborators. Rustagi, King, and Kirsch elaborate on the difference between formal and informal control:

> Scholars investigating control often make a distinction between formal and informal controls, noting that mechanisms used to exercise formal control are documented, while mechanisms of informal control are generally implicit (Kirsch 2004). Thus, written project plans, testing procedures, and job descriptions are mechanisms of formal control, whereas peer pressure, influence, and social events constitute informal control mechanisms. (2008, pp. 128)

Two prominent modes of formal control are behavior and outcome (Eisenhardt, 1985; Kirsch, Sambamurthy, Ko, & Purvis, 2002; Kirsch, 2004; Ouchi, 1979, 1980). Behavioral control involves following appropriate rules and procedures in performing pre-specified tasks. Performance is evaluated based on the extent to which the procedures were adhered to (Boss, S., Kirsch, Angermeier, Shingler, & Boss, R., 2009; Kirsch et al., 2002). Outcome control shifts emphasis to achievement of a stated goal, regardless of the process followed to achieve it. Successful performance is related to the extent the goals were met (Boss et al. 2009; Kirsch et al. 2002; Rustagi et al., 2008). Formal control is often explicitly exercised according to the organizational structure of a business. In a functional organization, a manager exerts control on an employee. In a matrixed organization, an employee's manager, or project manager exert control. In the project-oriented organization the project manager exerts the majority of formal control on team members. In all cases varying amounts of formal control are exercised in the hierarchy, or in the armed forces by the chain of command.

The method of informal control relevant to this study is clan control. A clan was defined by Ouchi "as a group of individuals who are dependent on each other, and who display a great deal of goal congruence, shared values, and norms, discipline toward their work, and 'solidarity' and 'regularity' in their

relations with each other" (Kirsch, Ko, & Haney, 2010, p. 470). Clan control, then, is the theory that a clan exercises control over its members via socially accepted behavior within the clan norms (Kirsch et al., 2010). Kirsch et al., also note "The mere existence of shared norms, values, vision, or agreed-upon behaviors does not indicate clan control; however, when actual behavior is influenced by those shared norms, values, vision, or agreed-upon behaviors, clan control is operating" (2010, pp 471). An interesting question may be asked when investigating implicit control within an organization: Which clan is an individual conforming to when behaving in a certain way? Is the clan the team, the department, or some other group an individual may consider themselves a part of? Rutner examines the emotional dissonance felt by IT professionals who are regularly expected to interface with both IT colleagues and workers in other functional areas who often display different occupational norms (2008). This dissonance is amplified in DOD and other government agencies where civilian contractors often work with members of the uniformed services. To which norms (clan) would an individual conform?

Further distinction in clan control focuses on input mechanisms and targets (Cardinal, 2001; Cardinal, Sitkin, & Long, 2004) as well as the role of clan control and behavior. According to Kirsch et al., the latter area investigates "the role of shared norms, values, and vision in *guiding and influencing behaviors*. Researchers who adopt this latter perspective tend to focus on the role of clan control in motivating specific behaviors of individuals in existing work groups" (2010, p. 471). Determining an individual's perceived clan affiliation is beneficial in determining the motivation behind an action. A seemingly nonsensical action may make sense when viewed in the appropriate clan context, which may not be obvious.

Different combinations of formal and informal control have been observed operating individually, or in conjunction, in different organizations. Cardinal, (2001), Cardinal et al. (2004) and Kirsch (1997, 2004) argue clan control can complement formal control, and they document informal control use in formal

business settings. “In the context of teams, it is possible to observe both lateral (peer to peer) control and hierarchical (manager to subordinate) control” (Kirsch et al., 2010, p. 471). Finally, Kirsch et al. (2010) argue control types may change during IT projects due to the evolving relationship between controller and controlee. Choudhury and Sabherwal (2003) concur, observing outcome controls dominate the initial phases of a project, with behavioral controls added later.

c. Funding Priorities

Funding priorities are often not directly stated (or known) until necessary. Although a portfolio is seldom fully funded, when this occurs there is little need to discuss which programs or projects are more important than others. In reality, budgets are often allocated yearly while projects may span multiple years. During long term development, discovery of new requirements or unforeseen difficulties can cause projects to overrun initial projections, which in turn causes a shortage of funds at the portfolio level (Oorschot et al., 2013). When this occurs in an already leanly funded portfolio, priority becomes critical. Indeed, this discussion is often contentious and confrontational when decided by committee rather than a single individual.

Prioritization in large organizations is problematic. Chun and Rainey (2005) address the issue in reference to US federal agencies:

> Priority goal ambiguity refers to the level of interpretive leeway in deciding on priorities among multiple goals. To indicate priorities means to make decisions about which goals should take precedence over others at a given time, or to form a goal hierarchy in which the goals are vertically arranged through means-ends relationships (Richards 1986). The presence of multiple goals without any hierarchical arrangement and prioritization leaves much room for interpretation of such priorities and about which goals take precedence. (p. 4)

Although Chun and Rainey use priority goal ambiguity as an empirical measure, the idea illustrates that priority determination becomes more complex as more goals or projects are considered. The statement on the consequence of the

absence of prioritization is critical. With too much room for interpretation of priority, personal preference, incompetence, and other informal or social concerns may become the basis for goal ranking, rather than importance to the overall organization.

A large organization may have hundreds of smaller systems within the IT portfolio. As Jung notes, partially based on the work of Chun and Rainey, organization size and complexity compounds priority ambiguity issues and can increase the number of goal conflicts:

> When public organizations have more goals, it will be more difficult to clearly set priorities among them, and thereby some type of organizational goal ambiguity (e.g., priority ambiguity) will be increased (Chun and Rainey 2005a). In addition, the presence of more goals can bring more occurrences of goal conflict. In other words, in public agencies with multiple goals, the achievement of some goals can be complicated or hindered by the achievement of other goals. (2013, p. 5)

An explicit method of clear prioritization would be ideal. Bardhan, Bagchi, and Sougstad proposed a portfolio valuation and ranking system based on real options, although they acknowledge "complexities of IT projects along with the effect of project interdependencies raise several challenges in applying real options for prioritization of IT investments" (2004, p. 33). Several other articles propose alternate models, including the "balanced scorecard" (Hu & Huang, 2006, p. 5), applications of the "dynamic capabilities perspective" (Chen et al., 2008, p. 366), and the "IT/Business Alignment Maturity" model (Luftman, 2003, p. 9). All proponents acknowledge the complex challenge involved, and emphasize business and IT alignment is a journey, not a state (Hu & Huang, 2006).

Bardhan, Kauffman, and Naranpanawe further reinforce the idea of goal conflict and the challenge of prioritization:

> IT budgets of many large corporations consist of several hundreds of IT projects and not just a handful. They all are simultaneously vying for funding approval. As a result, it is a significant challenge to identify and select those projects that are properly aligned with

> the firm's business strategy going into the future and then to implement them in a proper sequence in order to yield the maximal value for the organization. (2010, p. 2:2)

Not only is prioritization complex, project managers have a vested interest in seeing their project funded, and present compelling value arguments. With potentially hundreds of worthy IT projects to prioritize, how do decision makers determine which ones best align with business objectives? Substantial research has been performed regarding business and IT alignment from a portfolio view. Hu and Huang explain "Studies show that the lack of alignment between IT and business strategies is one of the main reasons why firms fail to realize the full potential of their IT investments" (2006, p. 3). Alignment of business and IT goals helps decision makers not only prioritize projects, but provides motivation to better support them. "IS development projects may take too much time, or even fail, if [senior management] commitment is erratic" (Newman & Sabherwal, 1996, p. 24) and "commitment is clearly important to the success of IS development projects" (Newman & Sabherwal, 1996, p. 23). Not only should decision makers establish clear funding priorities, they should communicate the priorities, in conjunction with the business strategies, to all levels of the organization.

d. Interdependencies of Implicit and Explicit Factors

Implicit and explicit factors are highly interdependent and interact both laterally between departments and organizations, and vertically, throughout an organization's hierarchy (which is itself also an explicit factor). As explicit vertical hierarchy increases, so does the potential for implicit factor influence. A classic example is telling the first person in a long line a simple fact and having them relay it to the next person, repeating this process until the end of the line. When the last person relays what they were told, there is a good chance it has changed from the original message. In the case of explicit organizational hierarchy, the desire to please your superior is an additional factor. Implicit control and capacity concerns may enter at any level. Lateral interaction includes firefighting syndrome, as well as concerns regarding clan control between groups. Sinha

and Van de Ven (2005) conceptualize work between and within organizations as shown in Figure 5 and this also serves as an excellent framework for this study. While the authors focus on work, the graphic and concepts apply extremely well in illustrating program and project complexity and the effect of organizational factors, both within an organization's IT portfolio, and across departments and related organizations.

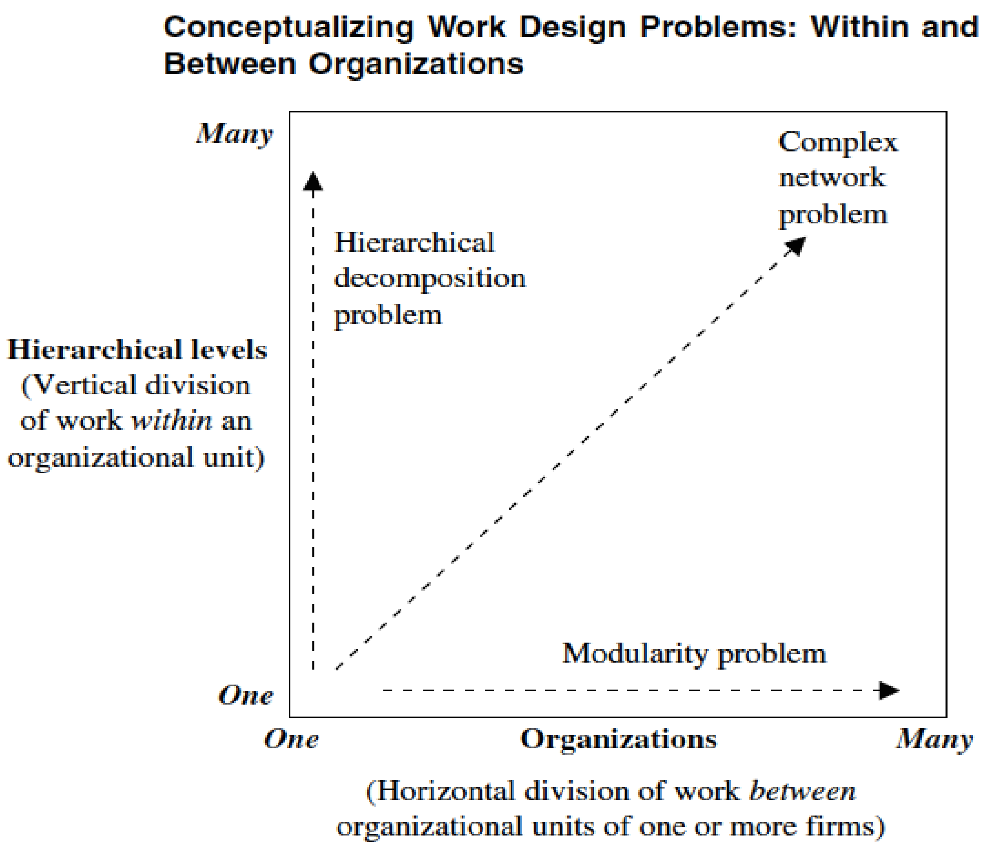

Figure 5. Conceptualizing Work Design Problems (from Sinha, & Van de Ven, 2005, p. 390)

In Figure 5, the vertical axis refers to work within an organizational hierarchy. Sinha and Van de Ven state "The resources, knowledge, and authority of a work system may be contained within one level of an organization, or it may be divided among many hierarchical levels" (2005, p. 390). In complex IT portfolios, explicit organizational factors typically operate vertically, influenced by

implicit factors. Resources are assigned in the form of funding, authority is assigned and derived from regulations, plans, and goals, and organizational knowledge is passed down. The horizontal axis illustrates how “the work system may be distributed across many organizational units of one or many firms, where each provides a component or module for an interorganizational network” (Sinha & Van de Ven, 2005, p. 390). In the language of IT portfolios, projects which are members of programs are often developed concurrently across lateral departments, or by similar departments in different organizations. Concurrent development is enabled by many object-oriented methodologies. Object definition and division of work can be difficult. Movement along the diagonal of Figure 5 represents the space where alignment of business goals and IT should take place. Organizational factors permeate the entire space.

Sinha and Van de Ven articulate three problems in the figure, which also apply to IT portfolio development. The modularity problem addresses the difficulty of dividing work between lateral departments or organizational units. At what point might outsourcing or subcontracting be considered when undertaking large program development? Where are the logical program divisions which would allow concurrent development among diverse entities? The hierarchical problem involves vertical division of responsibilities and authority. Often a program manager is at a higher hierarchical level than the project manager. The network problem is the most complex and the most problematic, created by the interaction of the previous two problems. Sinha and Van de Ven describe the network problem:

> When combining the two dimensions shown in Figure [5], we have a hierarchically differentiated work system consisting of interdependent modules that are performed by different organizational units in the work system network. The complex network problem represents the interaction effects of the modularity and hierarchy problems just discussed on coordinating work within and between organizations. (2005, p. 394)

In this context, the interaction possibilities of organizational factors on the IT portfolio are evident. It is also here where contagion may enter.

E. THE CONTAGION EFFECT

Research regarding the contagion effect is well established in financial literature, although not directly found in IT portfolio management literature. The firefighting syndrome as described by Bohn and Jaikumar can precede contagion (2000) and contribute to its propagation. The author proposes a contagion effect can spread from one problematic program or project within a portfolio to disrupt otherwise healthy projects, and supports this with a case study of two enterprise USCG IT systems. Parallels can be drawn between the spread of contagion in financial systems and the effect interconnected enterprise systems may cause via the complex network problem presented above, propagated by organizational factors.

> One theory is that small shocks, which initially affect only a few institutions or a particular region of the economy, spread by contagion to the rest of the financial sector and then infect the larger economy…When one region suffers a bank crisis, the other regions suffer a loss because their claims on the troubled region fall in value. If this spillover effect is strong enough, it can cause a crisis in the adjacent regions. In extreme cases, the crisis passes from region to region and becomes a contagion. (Allen & Gale, 2000, p. 2)

The analogous situation in an IT portfolio refers to either a program with interconnected projects, or simply interconnected projects, whether the interconnections are physical, operational, or implicit. The projects could be developed within one organization, or several. Perturbation to an aspect of the program can cause similar perturbations to the subordinate or connected projects. For example, a capability shortage to one project could affect completion of a component which the subordinate project requires in order to perform development. The schedule of the subordinate project is affected because it is unable to begin development in a timely manner. In another example, functionality in the parent program could be curtailed due to funding priorities, affecting schedule and functionality in interconnected programs. A series of such shocks to the program could eventually become a contagion from

which the subordinate programs cannot recover. As noted by Sinha and Van de Ven, (2005) when the number of organizations and levels of hierarchy increase, so does the complexity of the problem, and in the IT context, the magnitude and breadth of the impact of the contagion.

Another dissimilar yet complex operation from which parallels can be drawn is the area of mergers and acquisitions. Shaver described a negative side effect of mergers, which can also apply to interconnected IT systems:

> First, integration of the two businesses, in a way to effectively capture synergies, makes them more interdependent. Therefore, negative shocks to one of the businesses, stemming from changes in the environment or actions by competitors, are more likely to have an impact across businesses of the integrated firm, compared to if it had not been integrated. (2006, p. 962)

The application to IT portfolios in this case echoes that of the financial systems example, due to the complexity and interconnected nature of enterprise systems. “Interconnected” in this sense does not necessarily refer to technical specifications such as intra-system data exchange (though this can be true) but also includes interdependencies during the entire project lifecycle, such as requirements generation, design, and testing.

The contagion effect can also permeate the teams working on the programs and subordinate projects mentioned above. As a subordinate project is impacted by external shocks, an emotional toll is taken on the teams. Barsade studied “Group emotional contagion, the transfer of moods among people in a group, and its influence on work group dynamics” and showed “…that emotional contagion does occur in groups and inasmuch as emotional contagion changes people's moods and serves as affective information, people are ‘walking mood inductors,’ continuously influencing the moods and then the judgments and behaviors of others” (2002, p. 667).

Finally, the propagation of negative moods among teams influences the individual’s desire to perform. Rutner “examines an IT professional's emotional

dissonance…as a factor of IT professionals' work exhaustion, job satisfaction, and turnover intention" (2008, p. 635). Work exhaustion, in turn, leads to increased turnover (Moore, 2000).

Contagion effects move throughout the portfolio, organization, team, and individual levels with varying degrees of severity.

F. SUMMARY

In this chapter, the rationale for enterprise IT was explored. Development and management of enterprise IT systems and associated complexity was discussed. The importance of the portfolio, rather than simple project level view was emphasized. The concept of organizational realities, and the influence of explicit and implicit factors, was introduced. The contagion effect was defined and proposed to potentially result from interaction of organizational factors. The case study analysis of Chapter IV utilizes this structure to frame the results.

III. WATCHKEEPER AND MASI: INTERCONNECTED ENTERPRISE SYSTEMS

A. OVERVIEW

The WatchKeeper (WK) information system was a major acquisition managed by the USCG Acquisition Directorate (AD, CG-9), with development governed by the Major Systems Acquisition Manual (MSAM) and Systems Engineering Life Cycle (SELC). The Mission and Asset Scheduling Interface (MASI) information system was a non-major acquisition managed by the Command, Control, Communications, Computers and IT (C4&IT) Directorate (CG-6) in accordance with the USCG System Development Life Cycle (SDLC). In order to better understand what this means, an explanation of pertinent USCG organization and a primer on SDLC, MSAM, and SELC follows. Full SDLC and MSAM documentation is available from both the CG and DHS. The emphasis here is on the roles and responsibilities of the organizations, and the methodologies, specifically where they overlap, rather than on the process and steps themselves.

B. USCG PERTINENT ORGANIZATION

CG organizational structure as it pertains to the WK and MASI case study is presented here, along with primary roles and responsibilities. Figure 6 illustrates CG headquarters directorates. Pertinent to the case study are CG-6, CG-7, and CG-9.

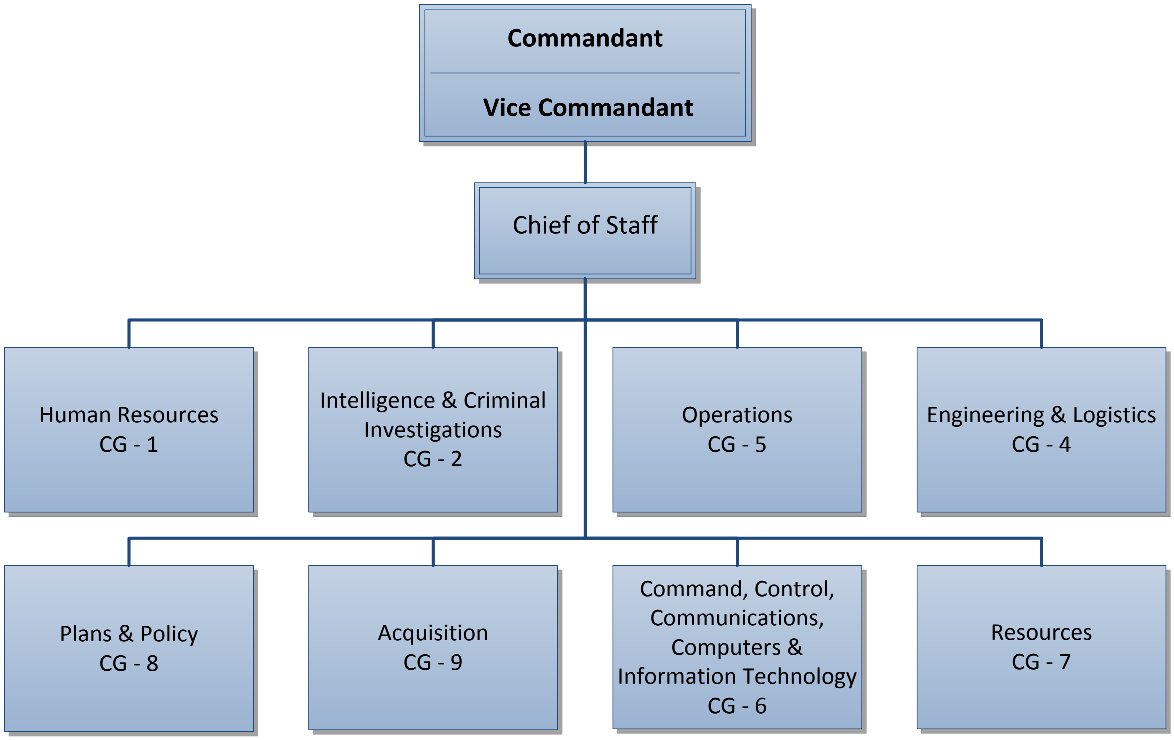

Figure 6. USCG Headquarters Directorates (after USCG, 2014)

1. CG-6: Command, Control, Communications, Computers & IT Directorate

Figure 7 illustrates the pertinent CG-6 organizational structure, and explicit lines of authority. Additional detail and divisions have been removed to avoid confusion.

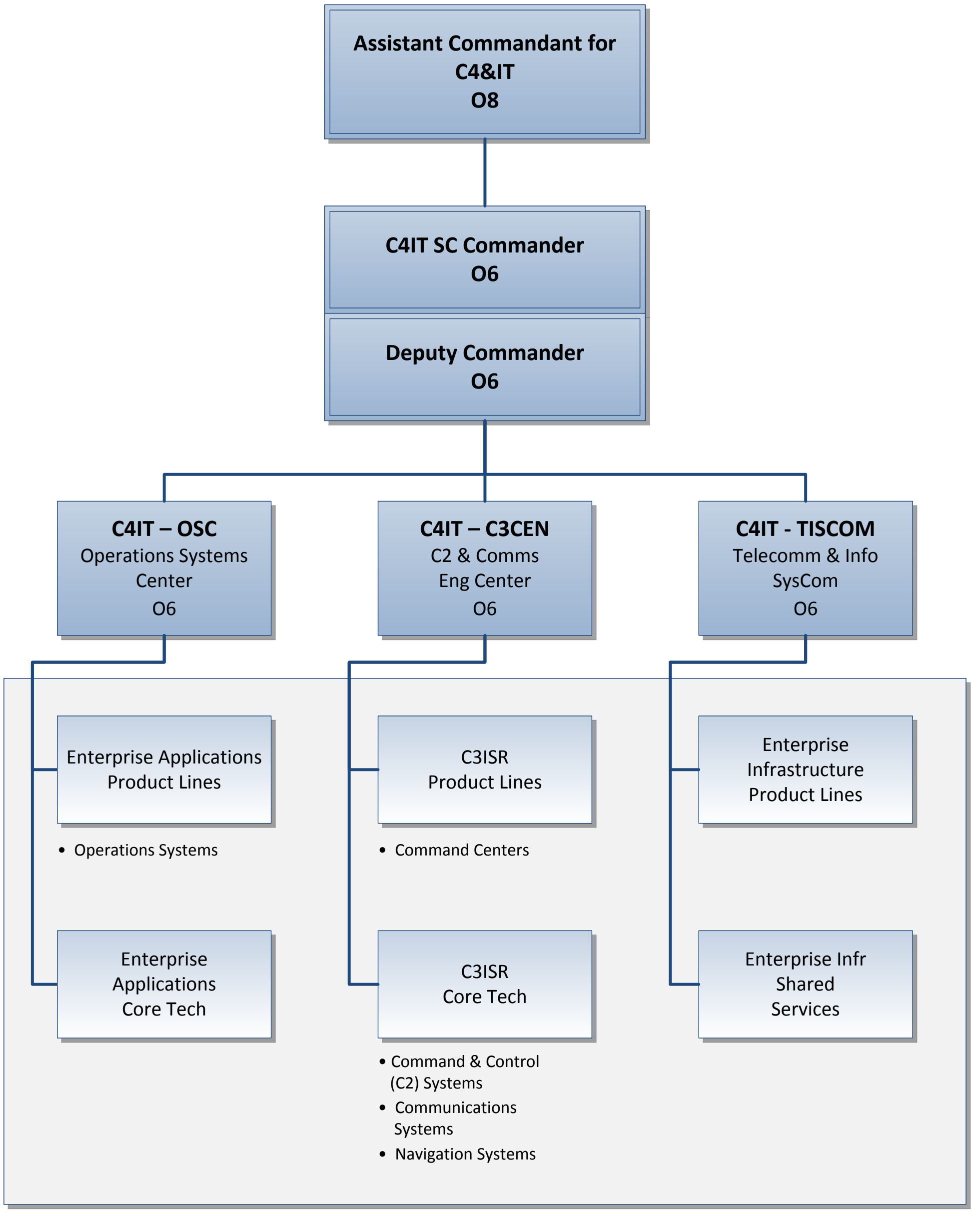

Figure 7. C4IT Service Center (SC) Organization (after USCG SC, 2014)

- **C4&IT Mission**: "The Assistant Commandant for Command, Control, Communications, Computers and Information Technology (C4&IT)/CG-6 designs, develops, deploys, and maintains C4&IT solutions for the entire Coast Guard to enable mission execution and achieve the Coast Guard's goals of maritime safety, security, and stewardship" (USCG, 2014).

- **C4&IT Vision**: “A Coast Guard ready with the right information at the right time to safeguard the Nation’s maritime domain” (USCG, 2014).
- **C4IT SC Mission**: “To be an adaptive and affordable service provider and protector of information and infrastructure that enable the Coast Guard to effectively execute its missions” (USCG SC, 2014).
- **C4IT SC Vision**: “Enable Coast Guard mission execution by providing high quality” (USCG SC, 2014):
    - Information and situation-awareness products and services,
    - Depot-level maintenance and repair services,
    - Resource transparency and total asset visibility, and
    - Stewardship and configuration management. (USCG SC, 2014)
- **C4IT SC Purpose**: “To enhance Command, Control, Communications, Computers and Information Technology's (C4IT) value in the performance of CG missions by providing and supporting systems and solutions that meet mission requirements” (USCG SC, 2014).

The C4IT SC was established February 9, 2009 with the intention of combining all CG C4IT under a single management structure:

> C4IT Service Center consolidates electronics and IT support, including that provided by C3CEN [Command, Control, and Communications Engineering Center], TISCOM [Telecommunications and Information Systems Command], OSC [Operations Systems Center], and the Base C4IT Departments in order to provide depot-level information-technology support for all mission requirements. (USCG SC, 2014)

Of note in the responsibilities of the C4IT SC is that they “Develop[s], test, deliver, and support all command & control, communications, computer and information technology systems, applications, and services” (USCG SC, 2014). Although the C4IT SC consolidates the COEs on an organizational chart, and provides another layer of hierarchy, operation of the individual COEs remained largely unchanged.

a. *Centers of Excellence*

The CG has three geographically separate centers of excellence (COEs) in IT which support the mission of the C4IT SC. The COEs are peer organizations under the C4IT SC. Duplication of effort is undesirable but due to largely autonomous operation of COEs before formulation of the C4IT SC, duplicative development efforts persist, particularly between OSC and C3CEN. The COEs each have a rich heritage, and firm commitment to success, but they also see themselves as individual clans from a control perspective, and often find themselves in competition, rather than cooperation.

(1) C3CEN: C3CEN is located in Portsmouth, Virginia. Among their responsibilities:

> The Command, Control, and Communications Engineering Center (C3CEN) develops, builds, fields, trains, and supports advanced electronic command, control, and navigation systems. C3CEN facilitates evolutionary engineering that focuses on the rapid deployment of essential functionality followed by planned improvements based on enhanced or refined requirements. (USCG C3CEN, 2014)

- **Mission**: "We deliver, manage, and support mission-enabling Command, Control, Communications, Surveillance, and Navigation Capability through engineering rigor and standard processes you can trust" (USCG C3CEN, 2014).
- **Vision**: "We will be the CG & DHS premier engineering, lifecycle, and service management center for Command, Control, Communications, Surveillance, and Navigation systems" (USCG C3CEN, 2014).

(2) OSC: OSC is located in Kearneysville, West Virginia, and more narrowly defines their focus on MAIS. "The United States Coast Guard Operations Systems Center (OSC) is a government-owned, contractor-operated facility with the primary function of providing full life-cycle support for operationally-focused Coast Guard Automated Information Systems" (USCG OSC, 2014).

- **Mission**: "The OSC develops, fields, maintains and provides user support for Coast Guard enterprise information systems to improve

Coast Guard mission performance through the innovative application of technology” (USCG OSC, 2014).

- **Vision**: “To be the Premier Software Development Center for the Coast Guard and the Department of Homeland Security” (USCG OSC, 2014).

(3) TISCOM: TISCOM is located in Alexandria, Virginia, and focuses on infrastructure as well as associated information assurance concerns. MAIS must satisfy TISCOM infrastructure requirements in order to operate on the CG network. “TISCOM is a part of the C4IT Service Center and serves as the Coast Guard's Center of Excellence (COE) for enterprise information technology infrastructure” (USCG TISCOM, 2014).

2. CG-7: Capability Directorate

- **Mission**: “Capabilities Provider—The directorate responsible for identifying and providing capabilities, competencies, and capacity and developing standards for the staffing, training, equipping, sustaining, maintaining, and employing CG forces to meet mission requirements” (USCG, 2014).

CG-7 is commanded by a rear admiral and includes several sub-units. Pertinent sub-units to the WK and MASI case study are:

- CG-741: Office of Shore Forces
    - **Mission**: “The mission of Coast Guard Shore Forces is to provide unity of command, and align shore structures to improve mission execution of all Coast Guard missions in the maritime domain” (USCG, 2014).
- CG-761 Office of C4 & Sensors Capabilities
    - **Mission**: “CG-761 is a team of professionals representing all mission communities who combine Coast Guard operations experience and various C4 & Sensors knowledge to achieve mission execution capability and system interoperability with outside agencies. Using this unique combination, CG-761 liaisons between stakeholders, user communities and technical authorities to generate requirements, set priorities, and negotiate fulfillment of user C4 & Sensor needs” (USCG, 2014).

3. CG-9: Acquisition Directorate

- **Mission**: "Efficiently and effectively deliver the capabilities needed to execute the full range of Coast Guard missions" (USCG AD, 2014).

The CG Acquisition Directorate was established in 2007, consolidating prior directorates and offices in order "to provide a single point of management and to act as the systems integrator for all Coast Guard Major Systems Acquisitions" (USCG AD, 2013, p. 1.2). CG-9 is commanded by a rear admiral, and manages significant funds. "The Coast Guard is investing approximately $30 billion in major acquisition projects that purchase and modernize the service's ships, boats, aircraft, and command, control, communication, computers, intelligence, surveillance and reconnaissance (C4ISR) systems" (USCG AD, 2014). Acquisition directorate projects include major information systems development such as CG-LIMS (enterprise logistics), Rescue 21 (direction and location), and IOC (includes WK). Of particular interest to WK and MASI are:

- CG-93: Director of Acquisition Program Executive Officer
  - "Provides certified acquisition management of the Coast Guard's investment programs. CG-93's Level 1 (totaling more than $1 billion in lifecycle cost) and Level 2 (totaling between $300 million and $1 billion in lifecycle cost) projects deliver the service's next-generation aviation, surface and C4ISR assets" (USCG AD, 2014).
- CG-9333: Project Manager (Command21/IPSOC)
  - Command21 was the prior name for the WatchKeeper project which is the "heart" of the Interagency Operation Centers mandated by the SAFE Port act of 2006.

4. CG-DCMS: Deputy Commandant for Mission Support

"The Deputy Commandant for Mission Support (DCMS) organization is responsible for all facets of life-cycle management for Coast Guard assets, from acquisition through decommissioning" (USCG DCMS, 2014). CG assets include acquisitions and IT systems. DCMS holds technical control over CG-6 and CG-9 and is commanded by a vice admiral (O-9).

> The four DCMS Assistant Commandants, CG-1 (Human Resources), CG-4 (Engineering and Logistics), CG-6 (C4IT) and CG-9 (Acquisitions), coordinate the planning, policy and budget for six Logistics and Service Centers in the field. The centers provide the technical authority and oversight for maintenance and support of all Coast Guard assets. (USCG DCMS, 2014)

5. CG-6 and CG-9 Interaction in IS Development

The activities of CG-6 and CG-9 have the potential to overlap, particularly in the case of IT systems acquisition and development, and they are directed to cooperate:

> Working closely with Coast Guard Headquarters partners, such as the Assistant Commandant for Engineering and Logistics (CG-4) and the Assistant Commandant for C4IT (CG-6), the Acquisition Directorate develops acquisition strategies that deliver affordable assets that meet mission requirements, as defined by the Deputy Commandant for Operations, and sponsored by the Assistant Commandant for Capability (CG-7). (USCG AD, 2014)

Although strategy is formed jointly, a major acquisition project is developed and controlled by CG-9. In enterprise systems, however, one system may rely extensively upon another system. A CG-6 system may become an integral part of a larger CG-9 system. In this case, who ultimately makes decisions for the CG-6 system? Figure 8 illustrates the process by which other CG directorates may have input in acquisition programs. System reviews with participation of CG-6 are typically at the senior executive level. The executive oversight council (EOC) is described as:

> A Flag/SES-level forum that monitors major risks, addresses emergent issues, reviews [acquisition decision event] ADE exit criteria, and provides direction to cross-directorate teams as required to support successful execution of major acquisition projects. The EOC includes key stakeholders in the acquisition process. (USCG AD, 2013, p. 7.2)

Although the EOC includes stakeholders, they are also at the senior level. A potential issue in portfolio development involving CG-6 and CG-9 systems is lack of direction to the cross directorate teams due to the abstracted view seen by

senior management. The EOC, by its nature, is more focused on major risks and emergent issues than resolution of system requirements or interoperability concerns at the touch-points between CG-6 and CG-9 systems at the development level. Raising low level concerns to the attention of the EOC is not typically practical or preferable. If the sponsoring directorate between the different systems is the same, requirements can be clarified between systems; however coordination of development schedules remains problematic.

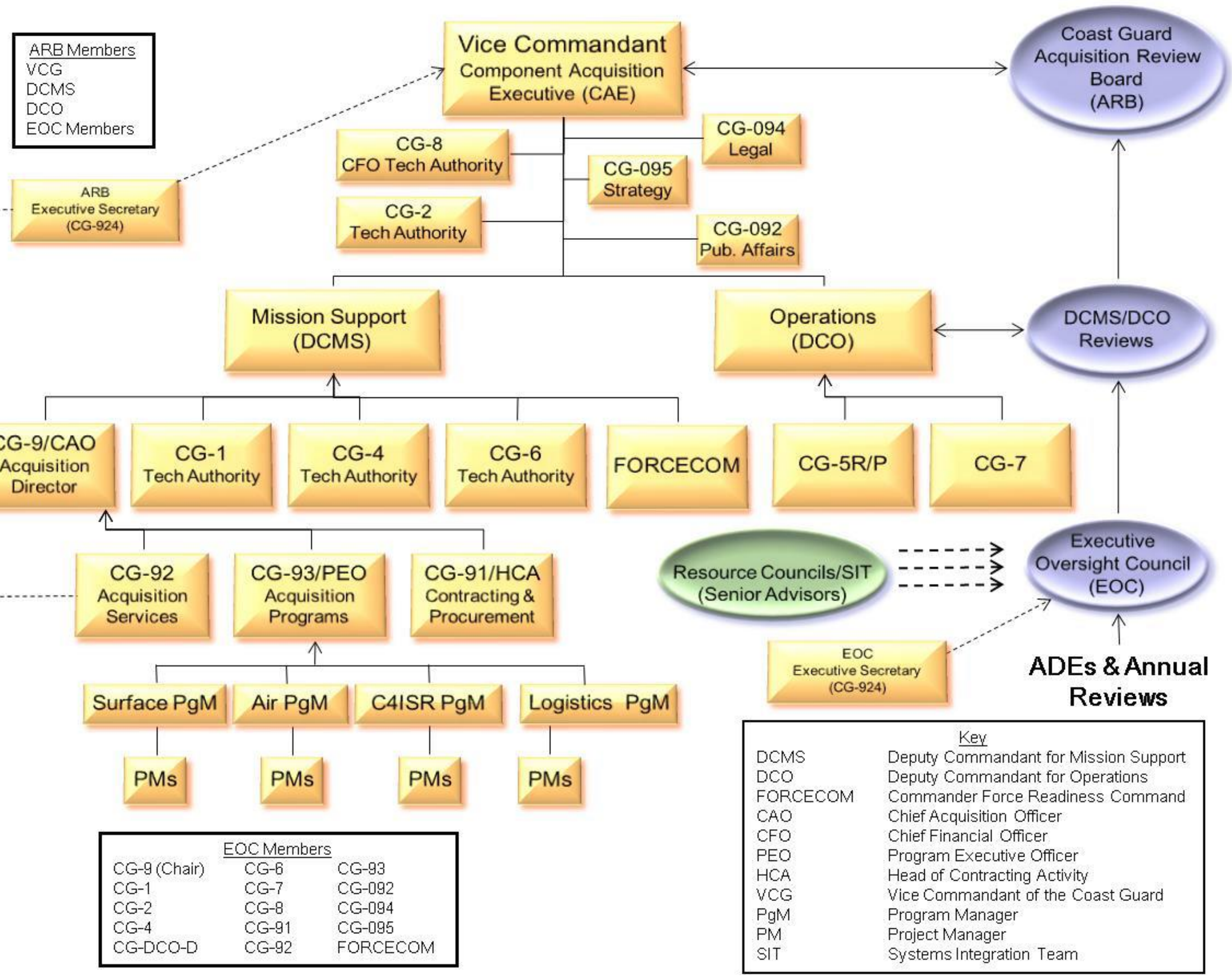

Figure 8. Coast Guard Acquisition Review Organization (from USCG AD, 2013, p. 1.6)

For additional detail in Acquisition Directorate organization as well as decision making bodies, see the USCG *Major Systems Acquisition Manual* (MSAM) referenced (USCG AD, 2013) below.

C. USCG SDLC AND MSAM/SELC

1. Overview

The CG acquisition process follows the DHS Acquisition Directive 102-01 series which consolidates DHS-wide acquisition management policy. MSAM governs major C4IT acquisitions, while SDLC governs non-major C4IT programs. “All USCG C4&IT acquisitions not following MSAM, shall follow the SDLC” (USCG C4IT, 2011, p. 1). When the need for a C4IT system is determined, CG-6 facilitates the decision process of major versus non-major primarily based on Life Cycle Cost Estimates (LCCEs). All potential systems are initiated within the SDLC process. When an acquisition is determined to be “major,” MSAM processes will be followed. SELC is part of the MSAM process. “MSAM includes satisfying the requirements of the SELC. Commandant (CG-6) is responsible for conducting SELC Reviews” (USCG C4IT, 2011, p. 29). Figure 9 illustrates the high level process.

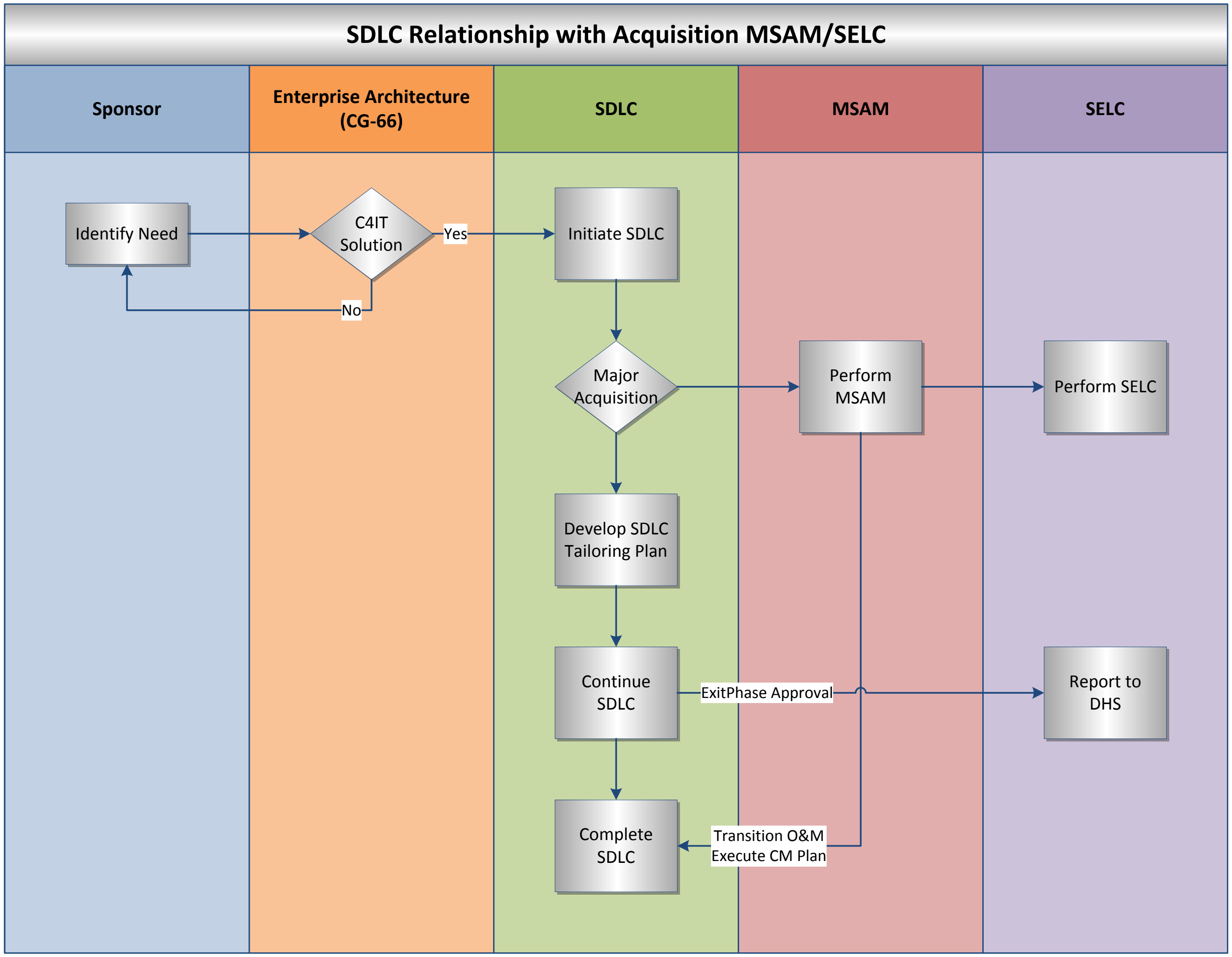

Figure 9. Major (MSAM/SELC) and Non-Major (SDLC) Acquisition Flow (from USCG C4IT, 2011, p. 30)

2. SDLC Purpose, Scope, Roles, and Responsibility

- **Purpose**: "The Coast Guard SDLC process is a comprehensive management approach that conceives and implements technology solutions designed to ensure that the right organizations and individuals are involved in each phase of the process, thereby raising the probability of success" (USCG C4IT, 2011, p. 1).
- **Scope**: SDLC applies to all non-major C4&IT systems.

Figure 10 illustrates the SDLC roles and responsibilities framework. The framework establishes directorate roles and illustrates the coordination necessary for C4IT system and services development. The three groups shown impact stakeholders, users, and customers (USCG C4IT, 2011).

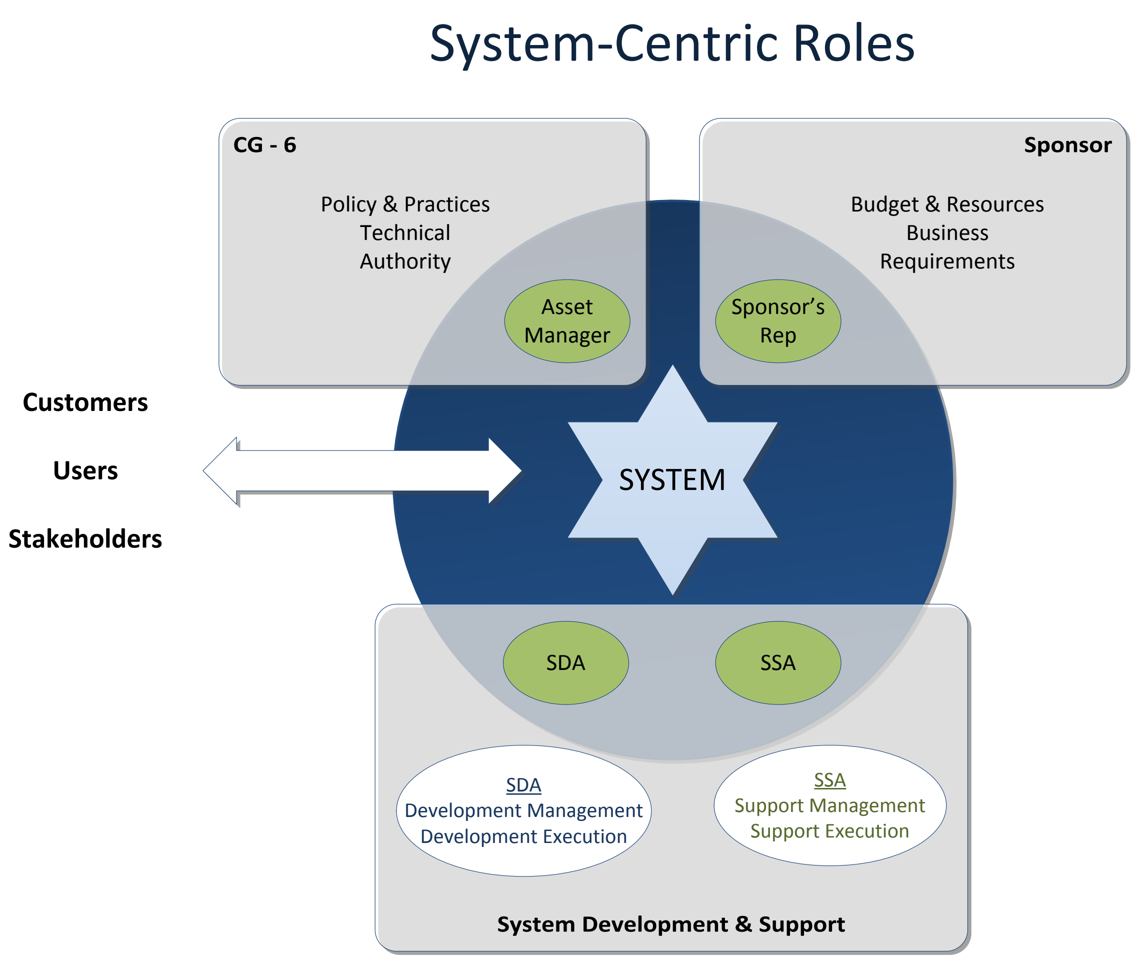

Figure 10. SDLC System Centric Roles (from USCG C4IT, 2011, p. 3)

- **Asset Manager (AM)**: “Shall guide, oversee, and monitor execution of SDLC for the assigned system. The Asset Manager shall collaborate with the Sponsor’s Representative, the SDA, and the System Support Agent (SSA) to ensure alignment and compliance with SDLC policies and practices” (USCG C4IT, 2011, p. 4).
- **Sponsor**: “The sponsor has typically identified the ‘need’ and hence defines and validates program goals and functional requirements, and officially accepts the final system. Interaction with the sponsor via the sponsor’s representative is critical to defining the right system. Among the sponsor’s responsibilities is acquiring the resources to implement and support the system through collaboration with the sponsor’s representative and the asset manager. In keeping with the responsibility to define requirements, the sponsor identifies and facilitates resolution of issues related to requirements” (USCG C4IT, 2011).
- **Sponsor’s Representative**: “Designated by the sponsor to directly liaise with AM, SDA, and SSA. This team works closely with each other, customers, users, and stakeholders. The sponsor’s representative is responsible for articulating requirements on behalf of the sponsor, as well as developing cost estimates and resolving development issues with the team at this level. Also relays change requests and collaborates in creation of the SDLC tailoring plan” (USCG C4IT, 2011).
- **System Development Agent (SDA)**: “The identified individual, unit, firm, agency, or organization that performs, or has the responsibility for, design, development, and implementation of C4&IT systems, as well as the acquisition of C4&IT products or services” (USCG C4IT, 2011, p. 7). Collaborates with AM, sponsor’s representative, and SSA, as well as customers, users, and stakeholders.
- **System Support Agent (SSA)**: “The SSA is the identified individual, unit, firm, agency, or organization that has responsibility for maintenance, support, and availability of a system” (USCG C4IT, 2011, p. 7). Among SSA responsibilities are maintaining and supporting system services, sustaining availability, and defining, tracking, and reporting support measures (USCG C4IT, 2011).

3. MSAM/SELC Purpose, Scope, Roles, and Responsibility

- **Purpose**: “Acquire and deliver more capable, interoperable assets and systems, and high quality, timely services that support Coast Guard forces in executing missions effectively and efficiently” (USCG AD, 2013).

- **Scope**: Applies to all major C4&IT systems.
- **Program Manager (PgM)**: "The individual who has responsibility and authority to determine the strategic vision of a program [in this context, a specific portfolio of functionally similar systems]. The PgM is responsible for establishing a portfolio focus across projects within the portfolio. The PgM is accountable for establishing starts and closeouts, and communication with entities outside Commandant (CG-9)" (USCG AD, 2013, p. 1.10). Unlike SDLC, which is system oriented, MSAM adds a portfolio management approach in addition to the system oriented SELC process. Details regarding this critical function are available in the MSAM.
- **Project Manager (PM)**: "The PM is the chartered individual who has responsibility and authority to accomplish project objectives for developing, producing, and deploying a new asset with logistics support to meet identified operational requirements. The PM is accountable for meeting established cost, schedule, and performance parameters established by the Acquisition Decision Authority (ADA), and works under the guidance and supervision of the…portfolio Program Manager" (USCG AD, 2013 p. 1.7). PMs are required to integrate the three primary management areas shown in Figure 11 into a coherent strategy to achieve specific cost, schedule, and performance parameters for their assigned projects (USCG AD, 2013, p. 2.1). "The PM is the key individual for acquisition project execution. PMs are accountable for the successful execution of their projects. PMs' span of control is such that they must be autonomous, trained, resourced, empowered, and accountable to senior management for the effort. This all-encompassing level of authority and responsibility is the foundation for the Coast Guard's PM-centric acquisition execution model" (USCG AD, 2013, p. 1.8). The PM level is similar to that of the AM in the SDLC process.

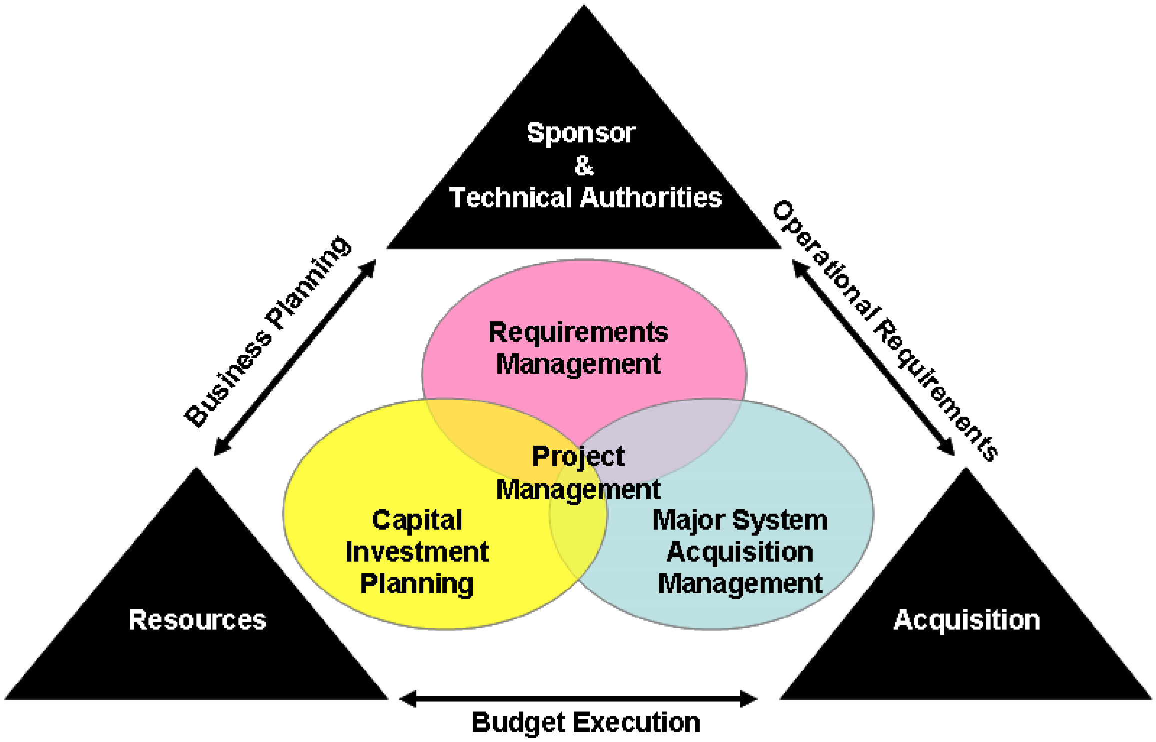

Figure 11. MSAM Management Interfaces (from USCG AD, 2013, p. 2.1)

- **Sponsor**: Similar responsibilities to those outlined in the SDLC process. For SELC reviews the sponsor is also known as the Lead Operational Authority (USCG AD, 2013).
- **Sponsor's Representative**: Similar responsibilities to those outlined in the SDLC process.

4. SDLC and MSAM/SELC Authority

The author is not an expert in either SDLC or MSAM/SELC processes, but the documents are ambiguous regarding whether CG-6 or CG-9 wields final control in C4IT system development cases. As seen in the sections pertaining to CG directorates, mention is made of collaboration. MSAM includes a description of Technical Authorities (TAs):

> The Commandant has designated TAs to serve as the Coast Guard's authoritative experts in providing the authority, responsibility, and accountability to establish, monitor, and approve technical standards, tools, and processes, and certify projects in conformance with statute, policy, requirements, architectures, and standards. (USCG AD, 2013, p. 1.15)

The TA for C4IT systems is CG-6: “Commandant (CG-6) is designated as the TA for the design, development, deployment, security, protection, and maintenance of all Coast Guard C4IT systems and assets. C4IT Systems Development Life Cycle (SDLC), COMDTINST 5230.66 (series), applies” (USCG AD, 2013, p.1.16). Yet in the SDLC manual under a section addressing major C4IT acquisitions: “Activities involved in the acquisition life cycle for major C4&IT acquisitions are governed by policies and practices outside of Commandant (CG-6), with Commandant (CG-6) satisfying an advisory and review role in the process” (USCG C4IT, 2011, p. 28). CG-6 formally reviews major acquisition progress during acquisition decision events (ADEs) using criteria defined in “SDLC Phase Exit Approval,” though MSAM does not follow SDLC. As such, CG-6 can require additional information from CG-9 during an ADE. Figure 9 also illustrates upon MSAM completion a C4IT system reenters the SDLC process flow for Operations and Maintenance (O&M). This suggests CG-6 is able to substantially influence the content and process of a major acquisition via the power of unfavorable reviews or refusal to accept an acquisition system to O&M, and also suggests CG-6 limitation of CG-9 PM authority. The process is further complicated when a portfolio view is embraced, or programs are considered rather than individual projects. A major acquisition program may include multiple projects, including non-major CG-6 projects. The problem introduced is lack of control clarity for individual projects under the larger program. Ideally collaboration between CG-9 and CG-6 would suffice, but explicit and implicit organizational factors may cause conflict.

5. SDLC and MSAM/SELC Phase Comparison

Although the emphasis of the case study is roles and responsibilities for SDLC and MSAM/SELC, a comparison of the SDLC and SELC phases is presented for completeness. Figure 12 illustrates alignment between phases for the two methodologies.

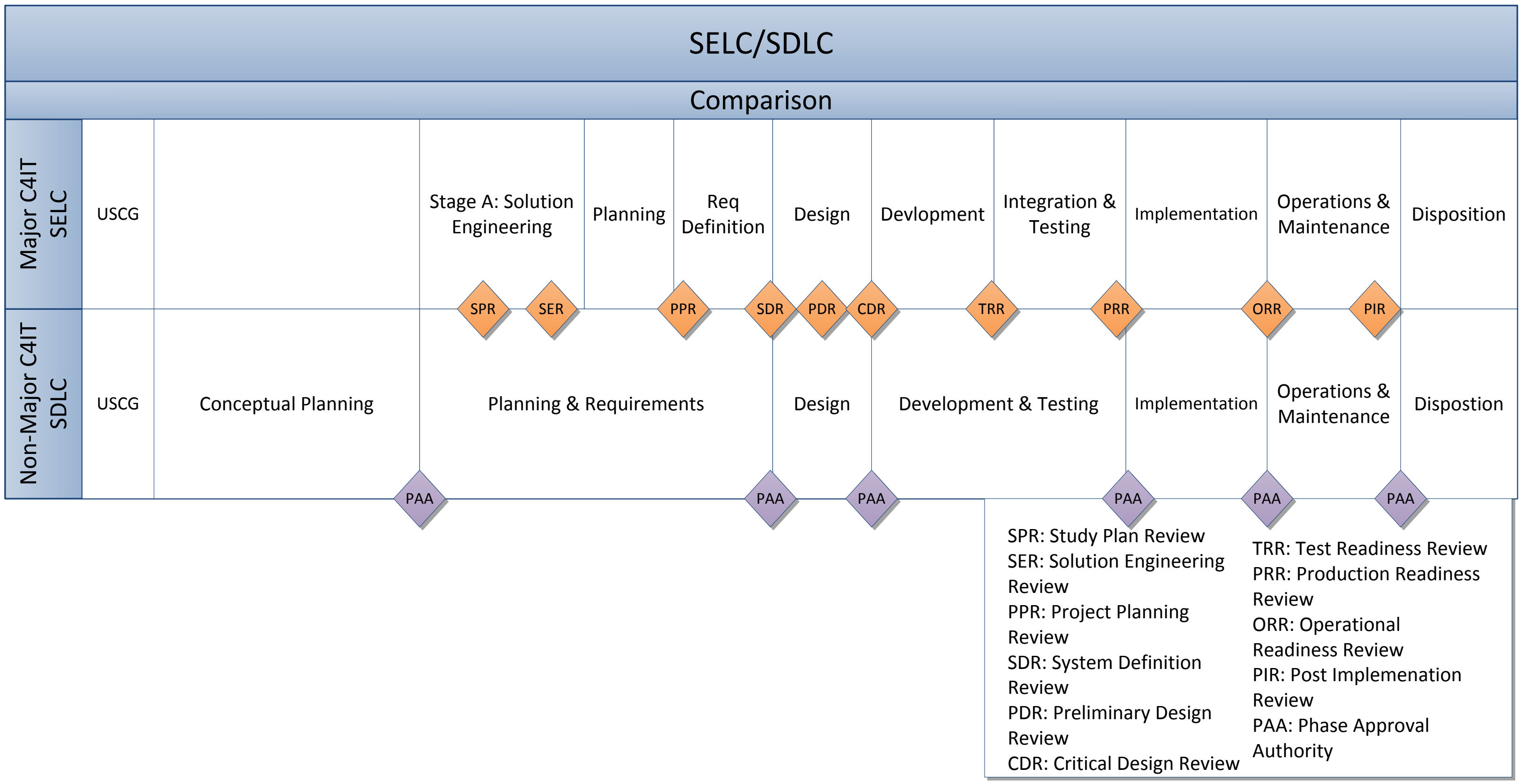

Figure 12. SELC and SDLC Phase Comparison (after USCG CG6, 2011, p.17)

D. WATCHKEEPER

1. Purpose, Capability, and Objectives

WatchKeeper (WK) was the enterprise IT system to be designed in support of the Interagency Operations Centers (IOC) project mandated by section 108 of the Security and Accountability for Every Port (SAFEPort) Act of 2006. Figure 13 is an early-concept graphic which illustrates WK as the aggregator of data from several other enterprise systems. The overarching IOC project involved WatchKeeper in addition to physical facilities and sensor networks.

Figure 13. WatchKeeper/C21 Early System Vision (from USCG AD, 2010)

- **IOC Acquisition Project Purpose**: "To transform Coast Guard Sector Command Centers (SCC) or other DHS infrastructure to host interagency members and meet the challenges of interagency coordination and maritime security. The volume of maritime domain awareness (MDA) information necessary to manage Coast Guard and interagency operations has increased dramatically and exceeded the field's capacity to collect and process it. As the Department of Homeland Security (DHS) lead for maritime security, the Coast Guard needs new information management capabilities to solve the coordination and operational challenges faced by today's interagency decision makers" (USCG CG761/CG741, 2010, p. ES.1). A primary purpose was to build IOCs in high priority ports.

Initial plans for the IOC project called for segment 1 to be the development and fielding of the WK system, while segment 2 would see further refinement of WK and integration with existing port and waterways sensor networks. Segments 3 and 4 exceed the scope of this study, and sensor integration was de-scoped and never implemented due to funding and development issues.

The WatchKeeper information system was envisioned to support three operational capabilities:

- **Integrated Vessel Targeting (IVT)**: "Integrates targeting results of agency-specific screening processes and builds a consolidated threat picture of people, vessels and cargo operating within IOC OPAREA as provided by intelligence and law enforcement communities in support of the Ports, Waterways and Coastal Security mission" (USCG CG761/CG741, 2010, p. ES.1).
- **Interagency Operational Planning (IOP)**: "Integrates federal, state, and local asset status and schedules. Mission Requests are created from Integrated Vessel Targeting results, along with other mission demand sources, such as regattas, patrols, and escort missions. These Mission Requests are prioritized by IOC decision makers, who assign assets to missions. These assignments form the IOC Daily schedule" (USCG CG761/CG741, 2010, p. ES.1).
- **Operations Monitoring (OM)**: "Manages the IOC Daily Schedule against all emergent events, such as search and rescue, spills, and other events occurring outside the operational planning window. Creates and shares the tactical picture, including command and control, mission status, and status of IOC forces/Blue Force Tracks (BFT)" (USCG CG761/CG741, 2010, p. ES.1).

Expectations were high for IOC and WK. The congressional mandate and DHS assignment of the CG to handle the acquisition were a major investment in the ability of the CG to deliver the expected system. Stakeholders identified in the SAFE Port Act included:

> U. S. Customs and Border Patrol, U. S. Immigrations and Customs Enforcement, Transportation Security Administration, the Department of Justice, the Department of Defense, and other Federal agencies, State and local law enforcement or port security personnel, members of the Area Maritime Security Committee, and other public and private sector stakeholders adversely affected by a transportation security incident or transportation disruption. (USCG CG761/CG741, 2010, p. 1.1)

These stakeholders were collectively referred to as "port partners" and enabling port partner participation in the WK system was a key priority. As presented in the Maritime Port Operations Handbook (2009) IOC objectives were:

- Provide enhanced information sharing between port partners.
- Foster planning and coordination efforts with local DHS and other Federal, State, and local partners on a regular schedule through designated points of contact.
- Coordinate local asset operations to improve mission performance, eliminate redundancy in mission execution and avoid mission conflicts.
- Conduct risk assessment and analysis, resulting in risk management of operations. (USCG CG-761 & CG-741, 2010, p. 1-2)

2. Development Methodology

The IOC project and WatchKeeper were a major acquisition under CG-9. As defined earlier, CG-6 was the technical authority for the WatchKeeper C4IT system, and WK followed MSAM/SELC processes. In 2012, WatchKeeper was officially downgraded to a non-major acquisition. For the majority of its development, however, it was a major acquisition, and after the downgrade it continued to be overseen by CG-9333. The extent to which the WK effort conformed to MSAM/SELC is not directly the emphasis of this study.

3. Roles

Chapter III, Section B defines relevant CG directorates and COEs. Chapter III, Section C.3 defines typical MSAM roles. Terminology in this section follows MSAM except where noted. WK roles are listed below:

- **PM**: CG-9333
- **TA**: CG-6
- **Sponsor**: CG-741
- Sponsor's Representative: CG-761
- **SDA**: C3CEN. Although SDA is an SDLC term, it accurately describes C3CEN as the lead developers of WK.
- **SSA**: OSC: SSA is also an SDLC term, but accurately describes OSC as maintaining WK physical servers, providing helpdesk support, and interfacing with other enterprise systems on behalf of WK.

Both C3CEN and OSC are CG or government run, with primarily a contractor workforce. Several contracting companies were involved in requirements gathering and development and will only be mentioned as pertinent to the case study.

E. MASI

Figure 14 illustrates a sample view of the MASI system as seen by an end user.

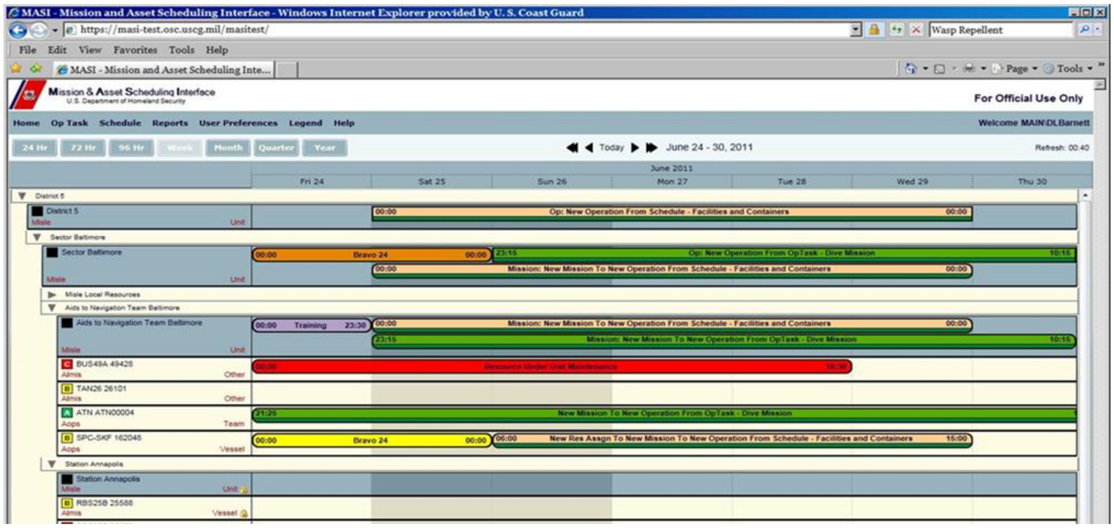

Figure 14. MASI Example Weekly View

1. Purpose, Capability, and Objectives

The predecessor to MASI was a system named MHS-Ops (Maritime Homeland Security Operations). MHS-Ops was originally selected by the WatchKeeper program as a nearly-ready capability which could fulfill WK IOP requirements. IOP requirements represented one third of the overall WK system (see Figure 15). MHS-Ops was a siloed system developed locally at USCG Sector Seattle, and used for planning and scheduling of sector assets at Seattle and other locations. OSC was identified to review the MHS-Ops system for suitability of inclusion in WK, and extension to full USCG use as an enterprise tool. Unfortunately, security and other operational flaws were revealed which not only made MHS-Ops unsuitable for enterprise use, or use with WK, but also identified its continued use as a risk to the CG. Fielding of an alternate system was ordered by CG-6, the designated approving authority (DAA), not only to serve WK requirements, but also to enable transition of MHS-Ops users and shutdown of the system. MHS-Ops users were distinct from WK users, and would not use WK.

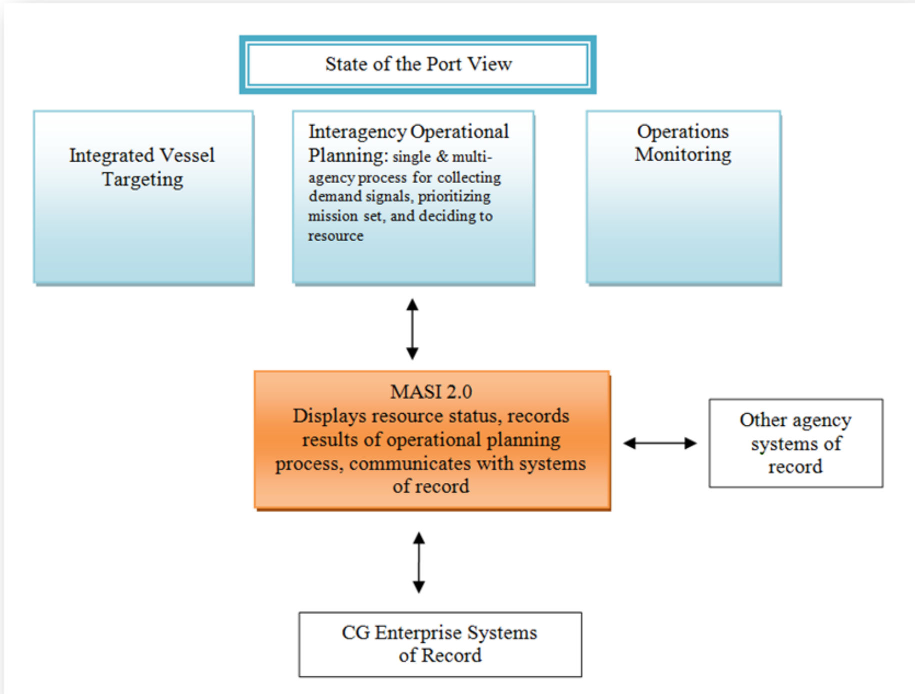

Figure 15. MASI Relation to WK Primary Capabilities (from MASI development documents, 2011)

The MASI project was conceived to deliver capability similar to MHS-Ops, but in an enterprise system which complied with established standards for security and quality. The system would be used by the USCG as well as provide IOP functionality for WK. Although MASI requirements would shift and grow significantly throughout development, its primary purpose was to provide a single view of missions which were planned, underway, or completed, the assets assigned to those missions, and asset status and availability. The tool would facilitate both horizontal and vertical transparency by creating a common operational picture, viewable by all decision makers. In the case of MASI functionality for WK, this included all port partners external to the CG, as well as their assets, and planning and scheduling needs. Desired MASI capabilities (non-WK specific) as outlined by LaSalle, included:

- A single user interface will provide a near-real-time presentation of all resources and statuses.

- A single user interface will provide a near-real-time presentation of all mission assignments planned, underway, and completed.
- A single user interface will provide a near-real-time presentation of significant events that will influence planning decisions.
- Planners will enter planning and scheduling information and decisions in one place: MASI.
- Units and command centers will then use MASI to manage the assigned missions and to support post-mission reporting.
- A single location will be available for the display of resource and mission planning and execution, optimizing resource utilization against the highest priority missions.
- Horizontal and vertical awareness will be provided for resource and mission planning, integration, and execution.
- The requirement for reporting will not change, but the system will support standard reporting procedures.
- MDA will be enhanced by providing command centers with single source visibility of all activities in the area of responsibility—planned, underway, and completed.
- The system will contribute to the standardization of data management and, by extension, an increase in data integrity within authoritative systems. (LaSalle, 2013, p. 38)

Figure 16 illustrates high-level MASI 1.0 architecture. Figure 17 shows MASI 1.2 architectural alterations created to enable WK State of the Port (SOP) functionality. Figure 18 shows the additional complexity required of the tool to support full WK IOP functionality. Appendix B details, at a high level, the complete re-architecture required between MASI 1.1 and MASI 2.0 to support WK IOP. The complexity required of MASI 2.0 was considerable. MASI users would reside in multiple security domains, and exceeded the set of WK users.

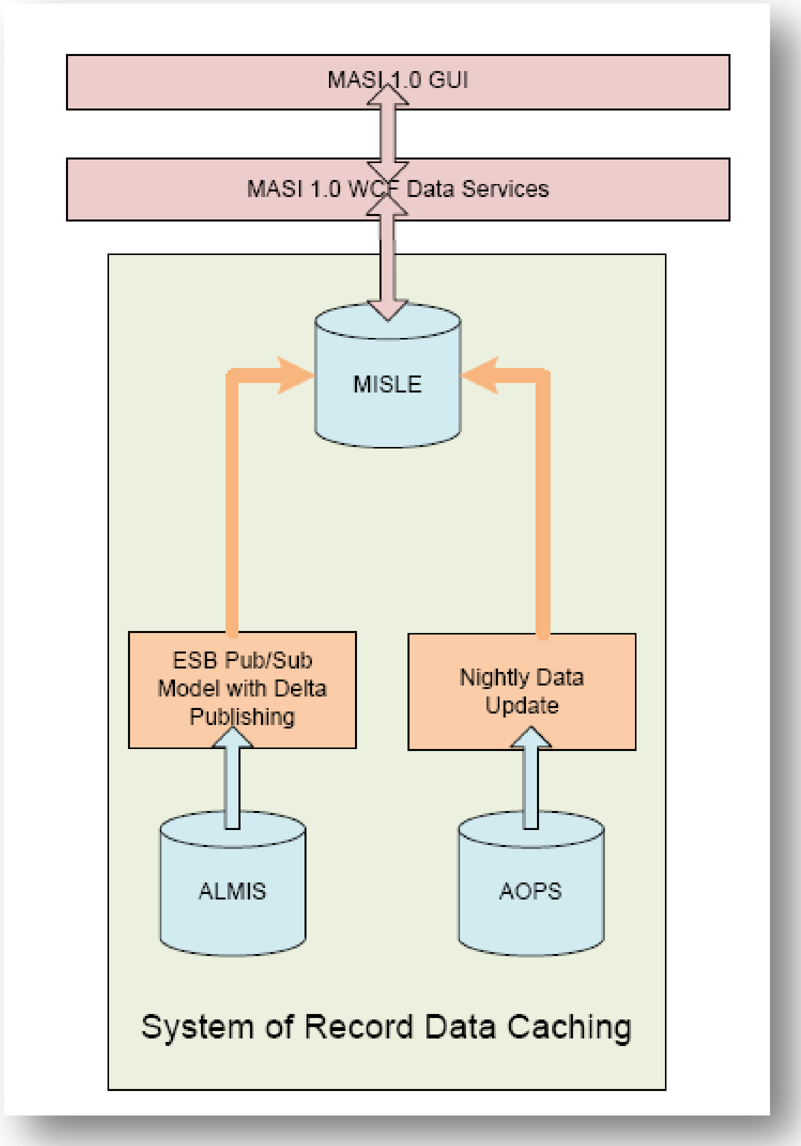

Figure 16. MASI 1.0 Architectural Diagram (from MASI development documents, 2011)

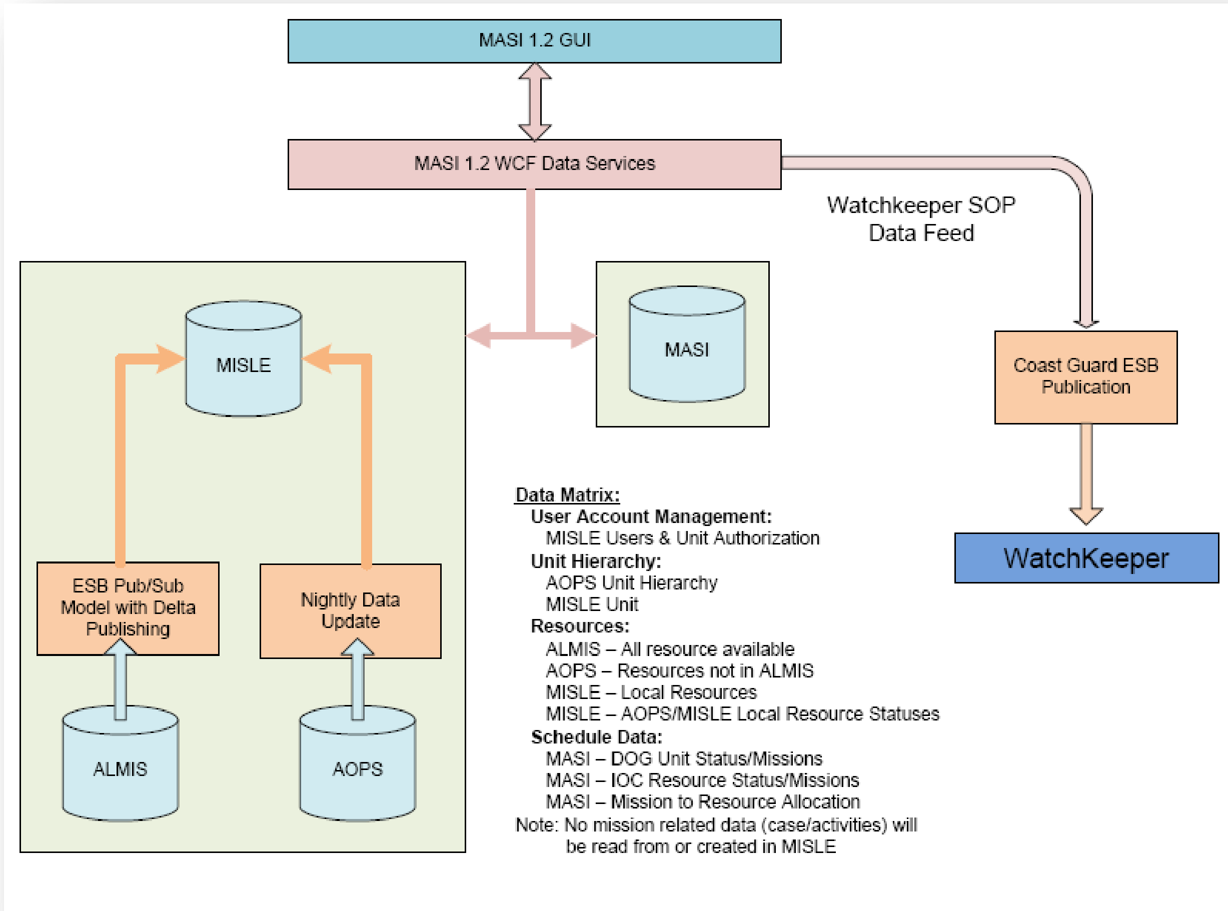

Figure 17. MASI 1.2 (SOP) Architectural Diagram (from MASI development documents, 2011)

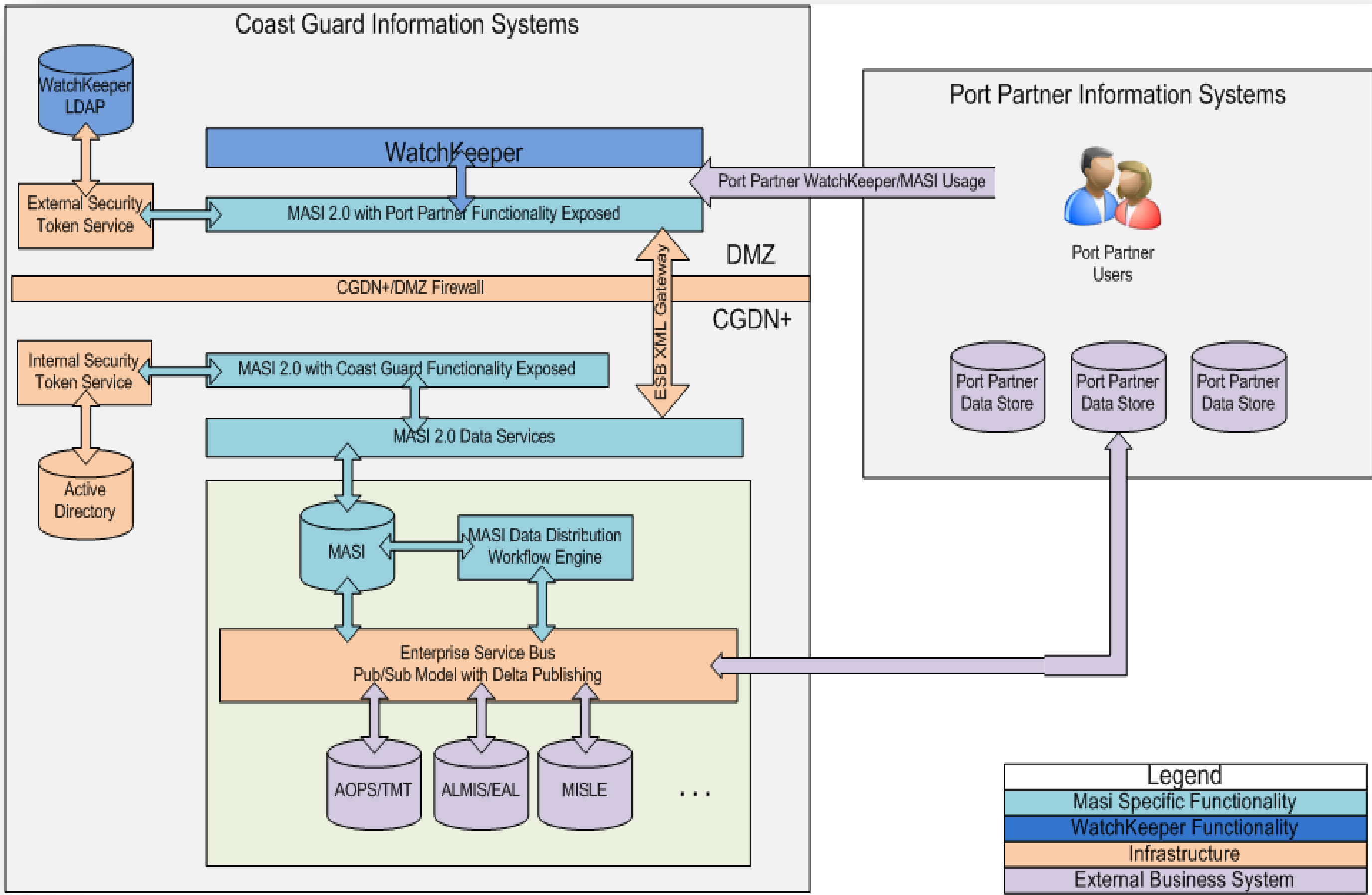

Figure 18. MASI 2.0 Notional Architecture in Support of WK IOP (from MASI development documents, 2011)

2. Development Methodology

The MASI project was a non-major acquisition under CG-6 and followed the SDLC process. Although MASI was expected to fulfill one third of WK functionality, it was not a subsystem of WK. It was an enterprise system in its own right that was expected to couple with WK to supply expected functionality. This placed the MASI system in the interesting situation of being a CG-6 project susceptible to CG-9 direction via an eventual WK master schedule. The dynamic was further complicated because CG-6 was the TA for WK, creating an ambiguous, potentially circular explicit authority structure.

3. Roles

Chapter III, Section B defines relevant CG directorates and COEs. Chapter III, Section C.2 defines typical SDLC roles. Terminology in this section follows SDLC. MASI roles are listed below:

- **AM**: CG-633
- **Sponsor**: CG-741
- **Sponsor's Representative**: CG-761. "Initially Sponsor and Sponsor's Representative roles were reversed, but for the majority of the project they were assigned as stated" (LaSalle, 2013, p. 33).
- **SDA**: OSC
- **SSA**: OSC

As mentioned, OSC is a CG facility, with a contractor workforce. CG-9 did not hold an official role in the MASI project from an SDLC perspective.

F. CONCURRENT DEVELOPMENT ISSUES WITH CG-6 AND CG-9 INTERCONNECTED PEER SYSTEMS

The preceding sections of this chapter have provided a great deal of information specific to CG operation and procedures for IT development and IT acquisitions. The information was not only provided to enable understanding of the WK and MASI case study analysis, but also to present the very complex web of directorate and procedural interdependencies involved. Less complicated examples certainly exist, and successful development of systems has been

accomplished by the same entities which became so entangled in the WK and MASI development. An IT system developed by a single COE, and overseen by only CG-6 or CG-9 has at least an industry average chance of success. The failure of the initial promise of WK and the final disposition of MASI were greatly influenced by the complex nature of the programs themselves, and the intricate web of intra-directorate funding priorities, clan control, and capacity issues. Chapter IV will demonstrate the significant roles played by the various directorates, both at the senior and middle management levels.

G. METHODOLOGY PART II—VALIDITY AND ANALYSIS

As mentioned in the “Methodology Part 1” section (Chapter I, Section F), validity is supported through the use of multiple strategies (Cresswell, 2009). Triangulation, rich narrative, member checking, extensive participant involvement and explanation of participant bias were utilized.

Using terminology from Chapter III, and assigned roles in Sections D.3 and E.3, the participant observer’s position within WK and MASI may be defined. The participant observer led the MASI SDA/SSA team, and led the WK SSA team. In the MASI SDA/SSA leadership capacity, the participant was directly involved in all MASI development team activity, all MASI requirements task order (MRTO) activity, was responsible for managing the project budget, participated in extensive meetings with the middle management (O-4) layer of various headquarters stakeholders (CG-633, CG-741, CG-761, CG-9333), met with C3CEN SDA’s, managed MASI project plans, and was responsible for weekly MASI SDA summaries provided to OSC command. The participant was also instrumental in all MASI system demonstrations to senior stakeholders, (O-6, O-7, Senior Executive Service—SES) and participated in several senior stakeholder program briefs. In the WK SSA leadership capacity, the participant interfaced between WK and all other OSC enterprise systems (Customer Service Department—CSD, Maritime Awareness Global Network—MAGNET, Marine Information for Safety and Law Enforcement—MISLE, Nationwide Automatic

Identification System—NAIS, etc.), provided WK infrastructure support, participated in middle management and senior stakeholder meetings, and completed a weekly summary of WK SSA events. The participant did not contribute to formulation of WK specific project plans or in assignment of development work. The participant budgeted support of the WK physical system and support, but was not involved in the WK development budget. The WK SDA team was located at C3CEN in Virginia, and the MASI SDA team was located in West Virginia. The participant's most detailed information originates from the MASI SDA position. Although the WK SSA position afforded the participant an extensive view of WK development, the exposure was less direct than that afforded by the MASI position.

Middle management interaction was a pervasive constant throughout the project timeline and often occurred at CG headquarters (CG-9333, CG-741, CG-633, and CG-761). Military middle management was typically at the lieutenant commander (O-4) level, and reported to the directorate heads at the captain (O-6) level. Influence at levels higher than captain was rare, and explicitly noted where it occurred. OSC and C3CEN development teams reported to HQ middle managers for project concerns (and to local superiors for COE issues). Middle management and senior leadership data has been gathered from official meetings and frequent emails, but no direct perspective was available due to geographical separation. The primary goal of the participant observer was to see both programs succeed but he had a more direct investment in the MASI program.

Given the inherent complexity involved in the WK and MASI story, simplification was necessary to enable focus on critical areas, while maintaining an overall narrative. To this end, hundreds of files, emails, requirements, and design documents for both WK and MASI were compiled and analyzed. These resources, in addition to participant program summaries, (spanning 2010 to 2012) were used to build a temporal timeline of significant WK and MASI events. This timeline was comprised of six event columns spanning 218 time segments

for a possible 1308 events, although the total was less because every event column did not contain an entry for each time segment. This list was further reduced to 40 significant and representative events, which are presented (Table 2) and briefly explained (Appendix A). The events were chosen prior to classification as "explicit" or "implicit," and predated formation of the propositions which emerged from the study. These events were classified according to primary organizational factors defined in Chapter II. From this list, an activity matrix was created which illustrates dependencies between events. From the activity matrix, an activity-on-node diagram was created to graphically illustrate temporal flow and event dependency. This diagram also represented "actors" in "swimlanes" to further clarify the primary "owners" of an event, or the primary recipient of event action. Selected portions of the timeline were selected for narrative treatment to further illustrate interdependency of organizational factors, the complex network problem, and contagion effect. From this analysis, four themes (sets of proposals) emerged.

H. SUMMARY

Explanation of explicit CG organization as it pertained to the case study was presented in this chapter. The SDLC and MSAM/SELC processes were reviewed not only to explain the explicit CG method for IT development and acquisition, but also to illustrate the ambiguous nature of the processes. WK and MASI were introduced to provide background on their intended purpose and to define their interdependencies at the conceptual level. Issues were discussed which arise during concurrent development of interdependent systems, one governed by SDLC, the other by MSAM/SELC. Finally, methodology and validity were discussed, as well as the method of analysis utilized in Chapter IV.

IV. WATCHKEEPER PORTFOLIO IMPACTS

A. WATCHKEEPER DEVELOPMENT ISSUES

The emphasis of analysis in this study is not the extent to which WK satisfied the objectives of the IOC program but rather an investigation into how its problems affected the MASI program, and to a lesser extent, other portfolio programs. A summary of published WK difficulties is presented below for completeness, as well as in support of claims presented during analysis. WK has had well documented developmental issues spanning the process from requirements through implementation. In two separate studies published in 2012 and 2013 the GAO notes the following regarding the IOC WK program:

- The Coast Guard has not defined WatchKeeper requirements, cost, and schedule in accordance with established guidance. For example, the Coast Guard designed and developed the initial WatchKeeper segment without first defining the specific functions that the system is to perform. (GAO, 2012, p. 2)
- The Coast Guard did not fully define requirements prior to designing, developing, testing, and deploying WatchKeeper. Recognized guidance calls for first defining business requirements that describe how users will interact with the system, and user needs in terms of what the system is to do and how it is to do it, to ensure that the developed system satisfies user needs…Although the Coast Guard developed draft high-level business requirements for WatchKeeper, it did not define the specific functions that the system is to perform. (GAO, 2012, p. 29)
- The Coast Guard has not developed a reliable cost estimate to guide and inform the WatchKeeper investment. For example, the estimate does not include all government costs, such as related program-management costs. (GAO, 2012, p. 2)
- WatchKeeper development and deployment has not been guided by a reliable schedule of the work needed to be performed and the key activities that need to occur. In particular, the schedule does not link all activities so that the project office can determine how a slip in a particular task may affect other related tasks, or the overall schedule. (GAO, 2012, p. 2)
- …according to the October 2009 IOC Project Management Plan, Segment 1 (WK) was to be deployed to all 35 sectors by March

> 2011 and Segment 2 by December 2015. According to the Acquisition Program Baseline, which was approved by DHS in September 2011, Segment 1 is now to be deployed to 17 of the 35 sectors by June 2012, and to the remaining 18 sectors and Segment 2 to all 35 sectors by March 2017. (GAO, 2012, p. 2)

- Prior to the initial deployment of WatchKeeper, the Coast Guard made only limited efforts to determine port partner needs for the system. (GAO, 2013a, p. 16)

When asked what they viewed as causes of WK problems, "Project officials attributed these limitations to an aggressive IOC development schedule, limited resources, and competing priorities" (GAO, 2012, p. 2). Although the officials interviewed by the GAO in 2011 did realize at a high level where the project had gone astray, they did not successfully alter the result by the time of the 2013 follow-on study (the focus of the 2013 study was not exclusively the IOC WK program).

In 2013, LCDR LaSalle also commented on WK's challenges from an internal perspective as the sponsor's representative (CG-761). Regarding the relation between CG-7 and C3CEN (formerly named C2CEN):

> Besides the normal disagreements and uncertainties that are present in any project, this project had a level of animosity between stakeholders because of military ranks that were involved. There were meetings where quarreling dominated the agenda, and there was a lack of trust between stakeholders that at times bordered on resentment. C2CEN felt that nobody trusted its efforts, while both directorates in CG-7 felt that C2CEN was not being honest with the development efforts that were underway. (LaSalle, 2013, p. 51)

Regarding the downgrade of the intended WK production release to "technical demonstrator":

> The WatchKeeper project also failed to meet testing events. Because of this failure, the Coast Guard finally decided—with pressure from the DHS—to reduce the scope of WatchKeeper. Therefore, in 2010, the DHS gave the direction that WatchKeeper was to be deployed as a technology demonstrator rather than a full-fledged system of record, which removed the MSAM requirements from the WatchKeeper effort. This decision came at a price. The

> WatchKeeper project realized substantial funding cuts, and there was operational backlash as well. (LaSalle, 2013, p. 52)

Unfortunately, as the remainder of the study demonstrates, WK was unable to contain the effects from its many developmental and managerial issues, as they rippled through the portfolio to affect MASI as well.

B. SIGNIFICANT WK AND MASI EVENTS ANALYSIS

As outlined in Chapter III, Section G, Table 2 contains the abbreviated list of significant events from the WK and MASI program timelines, which were used to construct the event matrix diagram in Figure 19. Table 2 contains the event number, event name, type, category, and severity. Severity is rated on a scale from one to ten, with ten as the most severe. The severity rating is relative to the effect of the event on the MASI program. For example, E6 represented a critical blow to WK, but had less direct effect on MASI, and therefore the severity rating is lower. If severity were geared to WK, E6 would have been an 8. Appendix A also lists the events of Table 2, but includes a detailed description of each event to include date, supporting details, historical context, implications, and impact. The severity ratings were assigned based on the effect of the event on the MASI program as a whole. In this manner, impact may differ from the severity rating. As an example, event E4 was more severe than E3, but the direct cost impact of E4 was significantly less.

Discussions of requirements in the CG reflect three levels of abstraction. Operational requirements are the highest description of need. Functional requirements are more specific, but still insufficient for system design. System level requirements are at the level required for coding and system design. Creation of system level requirements from functional requirements is often referred to as "decomposing" the functional requirements. This language is used extensively in Appendix A, and in the descriptions which follow. The brief listing of events follows in Table 2.

Table 2. WK and MASI Significant Events List

Event Number	Event	Event Type	Implicit Category	Severity 1-10
E1	IOC WK pORD Published	Explicit		3
E2	MHS-Ops Selected to Fulfill WK IOP Functionality	Implicit	Funding Priority	2
E3	Re-write (MASI Creation) and Discontinuation of MHS-Ops Mandated. Port Partner Access Critical	Implicit	Control	5
E4	MASI 1.0 not Accessible By WK Port Partners	Implicit	Control	8
E5	IOC ORD Published	Explicit		3
E6	WK Insufficient for Production Release, Approved for Release as Technical Demonstrator Instead, without MASI	Implicit	Control	4
E7	MASI 1.0 Test Deployment Failure at CG Sector Seattle	Implicit	Control	8
E8	Executive Oversight Council (EOC) "Getback" Meeting	Implicit	Control	4
E9	IOC APG Published	Explicit		2
E10	MRTO Created	Implicit	Capacity	5
E11	EOC Mandated October 2011 MASI 2.0 Development Completion	Implicit	Control	8
E12	CG-633/CG-761/CG-741 MASI 1.1 Prioritization Decision	Implicit	Control	5

Event Number	Event	Event Type	Implicit Category	Severity 1-10
E13	IOC FRD Published By CG-9333 Subcontractors. CG-9333 Attempts to Control and Limit MASI Requirements Generation	Implicit	Control	4
E14	Power and Control Struggles Begin at Initial MRTO and Stakeholder (CG-9333, CG-761, CG-741, C3CEN, and OSC) Meeting	Implicit	Control	6
E15	AMT Non-Delivery by C3CEN	Implicit	Capacity	6
E16	CG-9333 Provided Nine Months of MASI Funding for 2011 Development	Explicit		4
E17	MASI 1.1 Deployed, Users Happy. CG-761/CG-741/CG-633 Delay Official Release	Explicit		8
E18	MASI 1.1 SDLC Documentation Incomplete	Implicit	Capacity	5
E19	WK Does not Add Link to MASI 1.1 Contrary to EOC Mandate	Implicit	Control	4
E20	MRTO Team Restricted by CG-9333	Implicit	Control	5
E21	CG-761/CG-741 Do not Approve MASI 2.0 Functional Requirements	Implicit	Capacity	4
E22	Conflict Over FRD 1.1 Content Between CG-7 and CG-9333 Further Delays Creation of System Level Requirements	Implicit	Control	5
E23	C4IT-SC Brief: WK/MASI Concerns	Implicit	Control	3
E24	2012 MASI Funding in Doubt	Implicit	Funding Priority	7

Event Number	Event	Event Type	Implicit Category	Severity 1-10
E25	WK Does not Utilize MASI 1.2 for WK State of the Port (SOP) Contrary to EOC Mandate	Implicit	Capacity	4
E26	Change of CG-9333 PM	Implicit	Control	5
E27	MASI Development Team Begins RAD/JAD Methodology	Implicit	Control	4
E28	Status Brief to Assistant Commandant for U.S. Coast Guard Capability (CG-7 RDML)	Implicit	Control	3
E29	MRTO Staffing Issues/MRTO Extension	Implicit	Capacity	3
E30	CG-9333 Pushes for Fundamental Changes in WK/MASI Interconnection (Object Level Linkage)	Implicit	Control	6
E31	MASI 2.0 Non-delivery to WK for Integration	Implicit	Control	7
E32	CG-9333 Directs WK/MASI Technical Interface Meetings be Delayed Until December 2012	Implicit	Capacity	5
E33	Competition for 2012 Funds Between WK and MASI	Implicit	Funding Priority	9
E34	MASI Status Brief to RDML (CG-7) and SES (CG-6)	Implicit	Capacity	5
E35	CG-9333, CG-741, and CG-761 Hold "Simple Scheduler" Meetings Without Notifying OSC	Implicit	Control	6
E36	MASI 2.0 Demonstration to Senior Stakeholders/Funding Pitch	Implicit	Funding Priority	7

Event Number	Event	Event Type	Implicit Category	Severity 1-10
E37	RDML CG-7 Memo: MASI No Longer to Provide Any Functionality for WK	Explicit		8
E38	CG-761 Provides $200k Interim MASI Funding	Implicit	Funding Priority	3
E39	Loss of 55 Percent of MASI Team Over Four Months, Including Technical Lead and Senior Developer	Implicit	Capacity	8
E40	Course of Action (COA) EOC Meeting	Implicit	Funding Priority	10

The event matrix diagram (Figure 19) illustrates event dependencies. The diagram is temporal, and time advances down and to the right. Specific dates are less important than the sequence of events, but the dates are listed in Appendix A. The event in any given row has a dependency upon marked events in the columns. An example narrative description of event flow and dependency as shown in the matrix is given in Chapter IV, Section G. Due to the number of events, the matrix is cumbersome to interpret. Figures 20 and 21 map the events to an event-on-node diagram which reveals several insights concerning the data. These insights were used in formation of propositions discussed following the diagram.

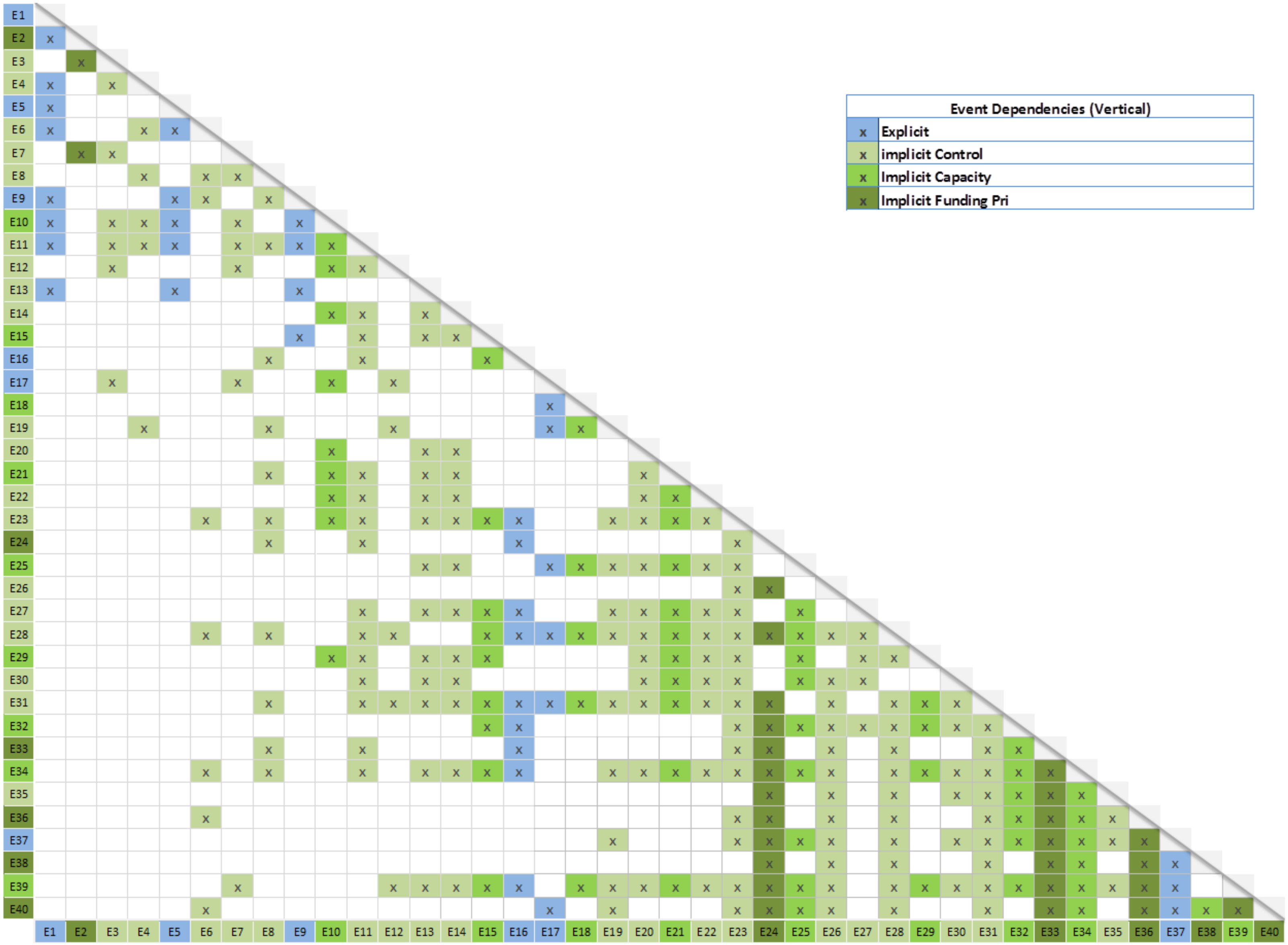

Figure 19. Event Matrix Diagram

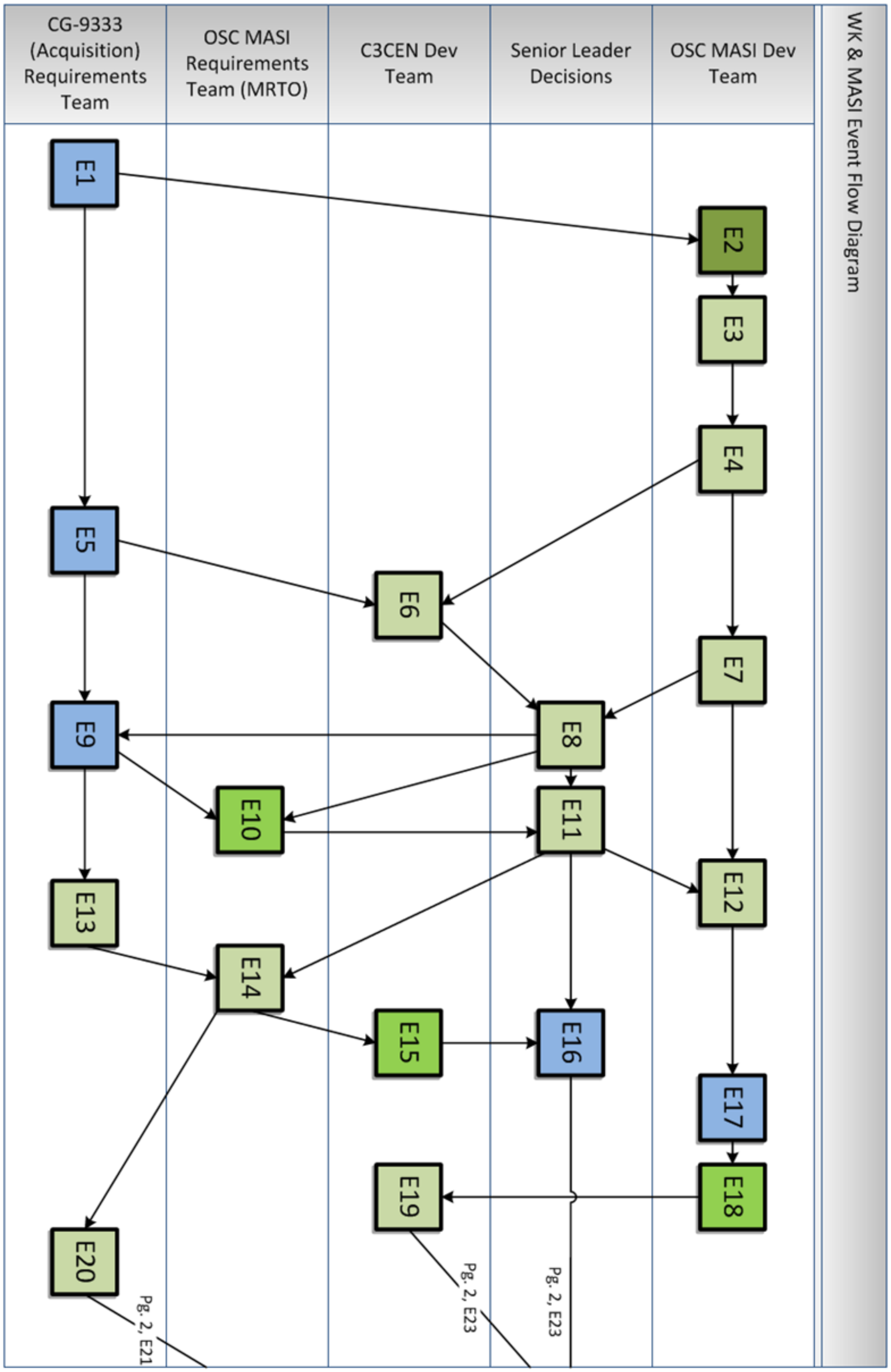

Figure 20. Event Flow Diagram Part 1

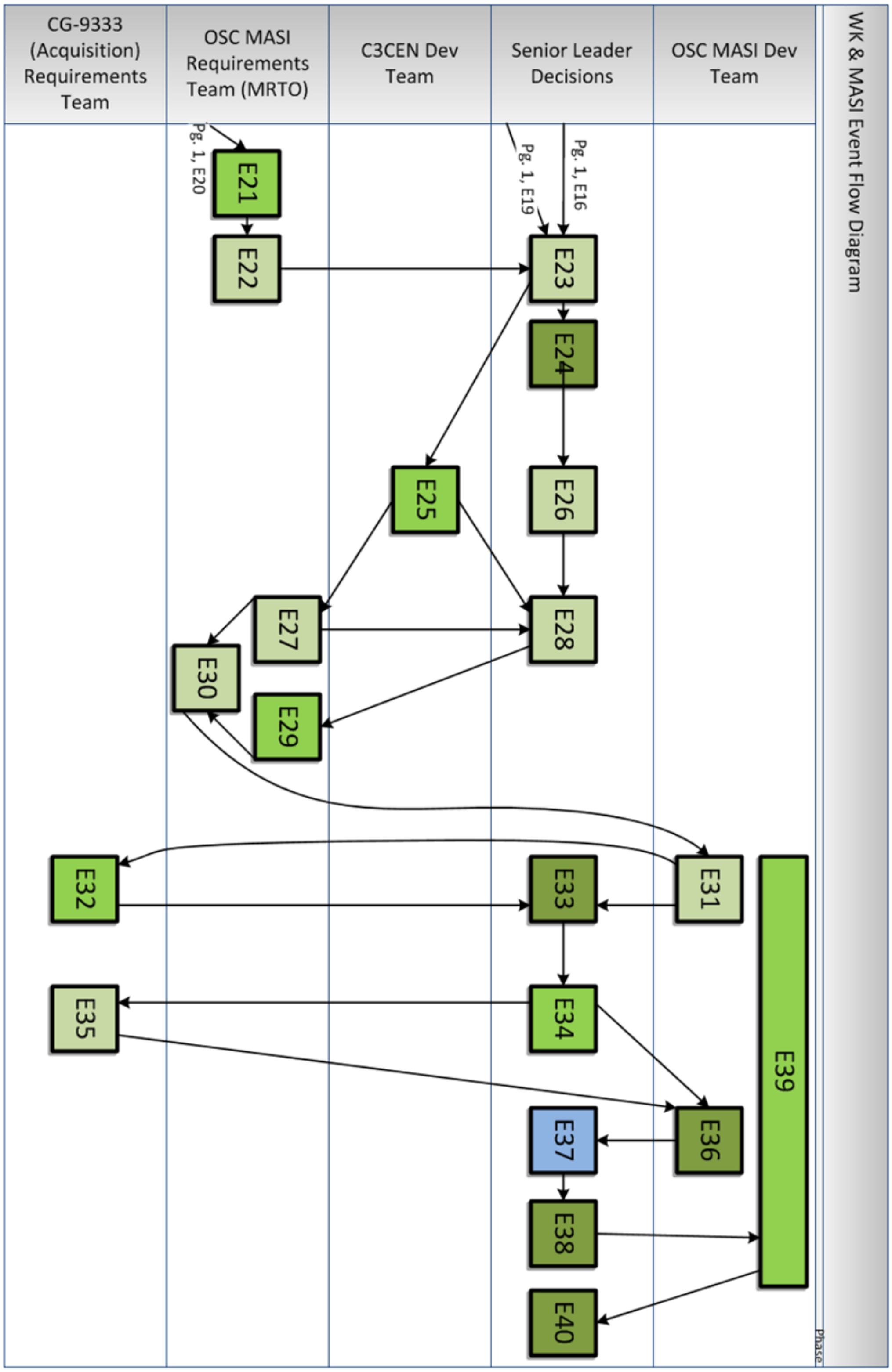

Figure 21. Event Flow Diagram Part 2

A cursory view of the events list reveals 15 percent of the issues were explicit, while 85 percent were implicit. Of the implicit events, 47.5 percent were control related, 22.5 percent were capacity related, and 15 percent related to funding priorities. From the event matrix diagram, dependency percentages were calculated as shown in Table 3. The relation of event and dependency percentages is shown in Figure 22. Implicit control issues dominate in both event and dependency percentages, but the dependency percentage also increases from the event percentages at the expense of the other categories. Although control is most frequently exercised, implicit funding priorities have the highest average severity. The event-on-node diagram, in combination with event descriptions (Appendix A), and project narratives, revealed the propositions discussed in the next sections.

Table 3. WK and MASI Average Severity of Events

	Explicit	Implicit		
		Control	*Capacity*	*Funding Priority*
Number of Events	6	19	9	6
Percentage of Total Events	15.00%	47.50%	22.50%	15.00%
Average Severity	5.5	5.26	5	6.33
Number of Dependencies	35	169	59	26
Percentage of Dependencies	12.11%	58.48%	20.42%	9.00%

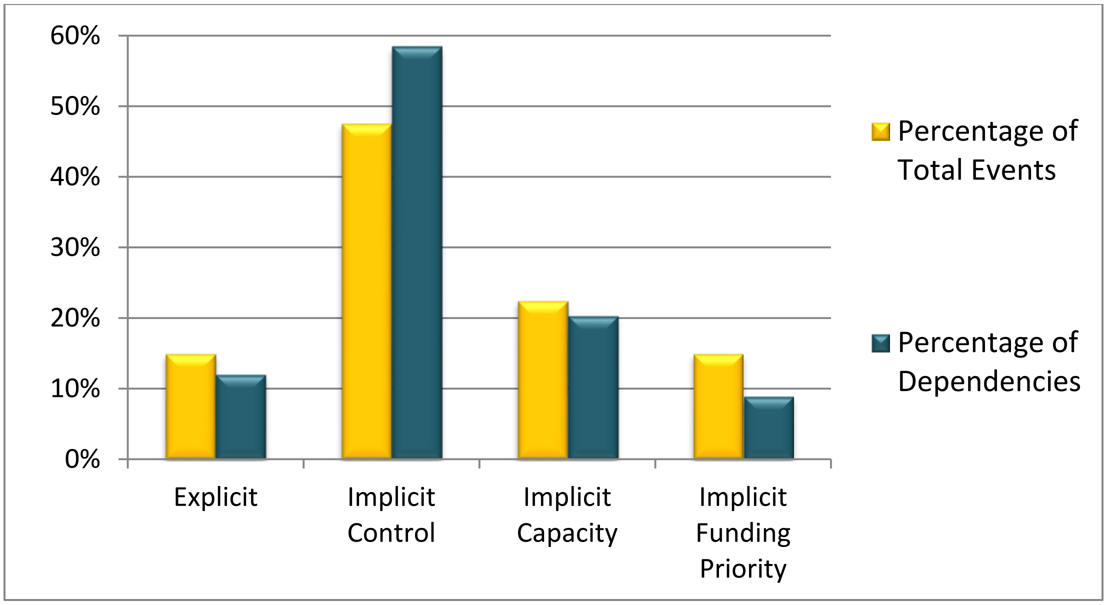

Figure 22. Percentage Comparison of Events and Dependencies

As the event matrix was mapped to the event-on-node diagram, commonalities became apparent. Groups of primary actors emerged and are represented in the diagram swimlanes. The OSC MASI development team was comprised of the SDA and SSA for MASI, as well as the development team. The OSC MASI requirements team (MRTO), was initially created to decompose high level IOC WK IOP requirements to the system level for use by MASI developers. The C3CEN development team contained the SDA for WatchKeeper, along with government and contractor developers. The CG-9333 acquisition team included mid-level acquisition managers and IOC WK specific requirements personnel. The OSC, C3CEN, and CG-9333 swimlanes represent clear clans from the control perspective, as well as organizations with separate capacity concerns. The “Senior Leader Decisions” lane included joint senior leadership meetings where decisions were made concerning the IT programs. An example of a senior leadership group with decision-making authority is the EOC (defined in Chapter III, Section B.5).

An extremely influential subgroup, however, is not explicitly present on the diagram, but exercised pervasive influence throughout the entire process and

over every swimlane. The group is middle management (defined in Chapter III, Section G), and they were present in all headquarters directorates, ostensibly acting on behalf of the O-6 directors. Middle managers were deeply involved representing CG-761, CG-741, CG-633, and CG-9333. They also represented individual clans from a control perspective, were often at odds, and formed shifting alliances in efforts to achieve their clan goals. Ideally, the overarching IOC implementation goal would have overridden clan boundaries and directorate power concerns, but this was not the case. As LaSalle pointed out specifically regarding WatchKeeper:

> The information that was passed to the decision-makers [by HQ middle managers] was often a more positive perspective than reality. No group was willing to be responsible for the failure of the project. Milestone deliverables and expectations were all managed in a way that would present the organizing group in the best light. From a program management perspective, it was very difficult to gauge the true pulse of the project given these realities. (2013, p. 52)

When the program experienced difficulties, clan delineations took precedence, rather than the portfolio goals. The effect of middle management is further detailed in the following sections as well as in event descriptions in Appendix A.

C. PROPOSITIONS ON ORGANIZATIONAL CAPACITY AND PROJECT EXECUTION

1. **Proposition A**: In the absence of clear tracking mechanisms, implicit capacity issues are very difficult to understand, resulting in systemic over-commitment of personnel and resources in complex organizations.
2. **Proposition B**: Firefighting is a common indicator of capacity issues, which can be incorrectly perceived as a project-level, rather than an organization-level, problem.
3. **Proposition C**: Systematic mechanisms for understanding and mitigating capacity problems at an organizational level are critical to avoid compounding project delays and portfolio impact.

Regarding IT portfolio management in complex organizations, capacity issues are typically hidden and easily misdiagnosed based on presentation of

associated signs and symptoms (Chapter II Section D.3.a). As complexity in a system increases, so do the number of possible causes for an undesirable event. A project milestone could be missed for many reasons within a small team: shifting requirements, equipment or software licensing delays, and unforeseen developmental issues. As program scope increases, several teams may be involved, adding to the list of possible causes: failure of other departments to meet their obligations, delay of important joint decisions, scheduling conflicts between groups, etc. Unfortunately, as higher management attempts to determine root cause, teams begin to consolidate along clan lines, obfuscating the effort in a desire not to be perceived as the cause. Indeed, if a group actually was the cause of the miss, they may legitimately believe the cause lies elsewhere, due to the difficulty of perceiving capacity issues.

In addition, reporting of events is often diffused by levels of hierarchy within organizations. A contracted development team may report to a manager, who then reports to the contract representative, who then addresses the customer for whom a milestone has been missed. The contract representative may be justifiably reluctant to report information which reflects negatively on their group. An analogous case within an organization (rather than a contractor), is middle management reporting to senior management. To further complicate matters, it is common to deny capacity related issues until they have become critical.

Project teams are typically highly motivated in the initial stages of project development and coding. They have a positive attitude and enthusiastically approach problem solving. At the team level, missing minor goals from day to day or week to week can be mitigated through shuffling the local schedule, applying more local resources to an issue, working longer hours, or compromising quality for a quicker solution. Efforts at this level are typically not reported to higher level managers, and in the example of a contract team, the contract representative does not report any issue to the customer because the problems at this point are contained. The middle manager does not report to their

superior for the same reason. Thus, the eventual failure to meet a milestone may be the culmination of several events, which are only partially understood at higher levels. Certainly the discussion of whether or not there is a fundamental capacity problem in some areas may never be contemplated.

In the WK and MASI case study, capacity issues were experienced by all groups in Figures 20 and 21 at various points. CG-761, CG-741, and CG-633 (HQ) experienced significant organizational level capacity issues and firefighting at the middle management level. The middle managers were each involved in work for multiple projects when MASI and WK alone required a full time effort (Proposition A). In this case, firefighting syndrome effects spread from these directorates and affected MASI development in particular. Events E10, E18, E21, E22, and E27 were all affected by capacity issues in these directorates. Creation of the MRTO team (E10) was necessary because the above directorates were unable to generate requirements in a timely manner (one of CG-741's primary duties, facilitated by the CG-761 sponsor's representative). The requirements generated by MRTO and the MASI development team, however, required specific approval by CG-761 and CG-741, which was delayed by firefighting on other programs and resulted in E21 (a delay of two months and churn by the MASI team). The effort of E27 was hampered for the same reason. MASI 1.1 SDLC documentation (E18) was unavailable due to CG-633 capacity issues, and was delayed by 5 months.

As indicated in Proposition B, senior leaders noticed MASI development was behind schedule and assumed the fault was with the OSC MASI team, rather than recognizing HQ capacity issues as a fundamental cause. The author assumes similar negative effects were seen in the other projects overseen by these individuals (due to their firefighting involving WK and MASI) but does not have specific data. Thus the capacity issues persisted throughout the program's duration and propagated to infect other programs in the portfolio, both directly and indirectly (Proposition C).

The OSC MASI development team did actively attempt to mitigate capacity issues in 2010 and 2011, but their options were limited and they did not receive support from senior leadership (Proposition A). Following event E11, the team immediately recognized they would be unable to meet the deadlines imposed given the limitations placed upon them. Having their projected schedule shortened by 33 percent and denied additional resources, they worked to reduce the scope of the project (according to the project management triangle, seen in Figure 4). They repeatedly briefed senior leadership and middle management regarding the capacity issues they faced, and were eventually successful in reducing program scope, but the success was largely negated by the unresolved HQ capacity issues mentioned above, and exacerbated by the imposition of significant additional work (E12). MASI implementation was negatively impacted by the decisions of senior leaders who largely refused to support capacity mitigation efforts (Proposition C).

Active vigilance is required to detect capacity issues. Immediately upon initial identification of what is perceived as a capacity problem, an evaluation should take place to determine if the issue is at a project or organizational level. The true cause should be sought, not to be confused with the visible signs and symptoms of the immediate problem. Definitive action must take place to either resolve the capacity issue (additional funding/personnel) or to adjust stakeholder expectations (schedule versus quality and functionality). If this does not happen, the capacity issue becomes worse, firefighting can commence if not already present, and schedule slips will broaden and increase to include affecting the schedules of dependent portfolio projects (Section F, Proposition A). Project plan dates become essentially meaningless in this environment, which is very important if other projects depend on your schedule (as was the case with MASI). If the problem is organizational firefighting, the project itself may be fundamentally sound (which was not the case with WK), and the schedule realistic, provided the firefighting problem is isolated from the project and dealt with separately by the organization.

D. PROPOSITIONS ON ORGANIZATIONAL CONTROL MECHANISMS AND PROJECT EXECUTION

1. **Proposition A**: In the absence of a clearly understood set of control mechanisms, the potential implicit control factor impact increases with organizational complexity.
2. **Proposition B**: Middle management perception of executive portfolio strategy is often limited, leaving them to utilize clan control mechanisms and unknowingly creating goal divergence.
3. **Proposition C**: Prudent use of implicit control by senior managers can greatly increase the chance of success and bridge clan divides.

Unless senior managers understand and plan for the impact of implicit control factors, they may discover they have lost effective control of their own program. With multiple levels of hierarchy, and the presence of several peer-level organizations, several clans (from a control perspective) will exist. With insufficiently defined explicit organizational controls, the available space for clan control to operate increases. People tend to act along clan lines, with portfolio concerns secondary. As Elonen and Artto (2003) note, project managers are often forced to utilize implicit control to secure resources for their project to the potential detriment of the portfolio. This is where middle managers wield their influence. They have enough power to materially influence the course of a project, and the wherewithal to disguise this from senior managers. If the senior manager does not firmly exercise explicit control, or utilize implicit control to his/her advantage, the middle managers may stray.

Although the CG is a military organization, with the accompanying hierarchy, IT portfolio development has consistently experienced control problems both vertically and across peer directorates. One senior leader commented that with so many directorates possessing veto power over the others, it was amazing anything was ever completed. Ostensibly, CG-6, CG-7, and CG-9 are peers, as explained in Chapter III. The COEs (OSC, C3CEN, and TISCOM) are peers with each other, under the CG-6 C4IT SC. In addition to the hierarchy described above, peers were implied by military rank. The WK EOC

was comprised of O-6’s from CG-633, CG-761, CG-741, CG-9333, OSC and C3CEN, among others. In this sense, OSC and C3CEN were both peers to CG-633 and subordinate to CG-6.

The formal control structure above inherently allows peer-to-peer implicit control issues when viewed in combination with their interleaved missions and responsibilities (Proposition A). In a complex program such as WK, formal control was further blurred (vertically) because CG-9 directed the development efforts of C3CEN, a CG-6 entity. WK program size and complexity increased control challenges. Development was geographically and organizationally distributed among various directorates and contractors. Lack of overall clear control mechanisms allowed dramatic influence from implicit control factors, as evidenced by the domination of implicit control dependencies seen over other factors in Figure 22 (Proposition A).

Peer implicit control factors were based on organizational hierarchical levels and military rank. Directorate leaders and senior peers influenced each other (events E8, E16, E23, E24, E26, E33 and E40). Middle managers at CG-633, CG-761, CG-741, and CG-9333 influenced each other (events E12–E14, E19–E22, E24, E30, E33, and E37). C3CEN and OSC cooperated at the lower levels, while their O-6 commanding officers interacted laterally at the senior level. Implicit control actions were overwhelmingly motivated along clan affiliations (described in Chapter IV, Section B) but often involved program and portfolio-wide consequences which were not necessarily intended by the originating clan (Proposition B).

An example originating with CG-9333 illustrates both horizontal and vertical implicit control, with unintended portfolio consequence. Events E13, E14, and E22 illustrate events where CG-9333 middle management attempted to control MASI requirements generation (lateral implicit control enabled in accordance with Proposition A). Their initial efforts resulted in limited control of MASI activity, although they did cause MASI delays. With the departure of the CG-9333 PM (E26), their middle management influenced the incoming,

inexperienced PM (vertical control), which allowed them to introduce E30 and E35, even though E30 was contrary to the directions of the prior PM. CG-9333 middle management desired control of MASI fulfillment of WK IOP functionality. When they did not obtain it to their satisfaction, they attempted to remove MASI as a requirement for WK IOP, which they were successful in doing (E37). As a result, C3CEN was forced to create an inferior (and largely manual) IOP solution, which fulfilled less than one fourth of the requirements MASI would have provided (Proposition B).

Creation of this solution impacted completion of other WK development, and was a critical influence to the cessation of MASI development (E40). During this time, the CG-761 director, secure in his explicit control, committed additional funds to MASI (E38) and ordered his middle managers to secure further funding. Contrary to his wishes, the middle managers advised the EOC to cease MASI development. Had the CG-761 director been aware of the implicit control struggles taking place around him, he may have been able to achieve his goal rather than being marginalized (Proposition C). Cardinal, (2001; Cardinal et al., 2004) and Kirsch (1997, 2004) argue clan control can complement formal control, and had he been aware, he could have used this to his advantage, both vertically and with his peers. CG-9333 middle management believed they were acting in the best interest of WK (Proposition B), and the result was a less capable tool and additional consumption of C3CEN development resources.

Developing a complex program across multiple organizations in the absence of sufficient control mechanisms allowed extensive influence by implicit control brokers. These middle managers, however, did not understand and support the portfolio view, and were susceptible to clan mentality. They attempted to optimize locally for their clan at the expense of the higher program and portfolio. The result was damage to their program, as well as to MASI.

E. PROPOSITIONS ON ORGANIZATIONAL FUNDING PRIORITIES AND PROJECT EXECUTION

1. **Proposition A**: When funding priorities are not clarified adequately, ad hoc decisions regarding one project can adversely spread to others in the portfolio.
2. **Proposition B**: Periodic assessment and recognition of funding vulnerabilities should take place at the portfolio level to ensure minimized negative portfolio-wide impact.
3. **Proposition C**: Following identification, realistic assessment of funding priorities at the project level must inform timely changes to scope, schedule, and quality.

IT portfolio funding requirements are dynamic. Multi-year projects attributed annual funding amounts experience unforeseen issues which may require additional funding or modification of project timelines and scope. When a major development program experiences significant upheaval, an analysis of portfolio impact should be performed in addition to program review. Enterprise IT systems have direct and indirect effect on other programs in the portfolio.

The MASI program was vulnerable to funding priorities from inception. CG-9333 managers initially chose MHS-Ops as an existing solution they believed would be usable at an enterprise level (E2). CG-6 identified MHS-Ops security vulnerabilities and mandated the program be re-written (E3). At this time, CG-6 should have identified funding in accordance with SDLC requirements. They did not realize, however, the scope of the project and proceeded without identifying sufficient funding in violation of the SDLC. Funding pressure directly affected schedules and design choices throughout. In 2011, in particular, funding priorities caused non-replacement of departing engineers. This fundamental vulnerability was fatal when WK realized they had funding troubles of their own for 2012, and competed with MASI to obtain them. Portfolio funding issues affected both MASI and WK as detailed below.

In July 2010, the CG-9333 PM realized the program possessed excess expiring funds which would have been wasted if unused. He wanted to maximize the value the funds could provide both to WK and other programs in the portfolio.

He polled the other programs providing direct or indirect services for WK, and determined whether they were experiencing funding shortages. The connection to MASI was direct, in that MASI was to provide WK IOP functionality. The PM funded the MRTO team (E10) and the MASI team for a portion of 2011 (E16). They also provided funding to the Enterprise Geographic Information System (EGIS). In that case, WK was one consumer of GIS data feeds which were also needed by several other portfolio systems, not directly linked to EGIS. These programs also benefited. Timely identification was critical to the responsible and effective allocation of the surplus funds in a manner where the benefit to the portfolio was maximized. It should be noted that the method followed by the CG-9333 PM to identify programs to benefit from the WK funding surplus was informal. He contacted the WK SSA located at OSC and inquired. In this case of surplus funds, priority goal ambiguity was not an issue, but ideally more formal routes would exist for CG-9333 to provide direct funding to CG-6 programs.

Funding deficits are more common than surpluses, and much more difficult and contentious, to mitigate. When CG-9333 provided 2011 funds for MASI development (E16) they stated no additional funding would be available in 2012. At the time, identified annual MASI funding was less than one third what development required. In April 2011, the OSC MASI team began briefing senior leaders on the fiscal 2012 funding shortage (six months prior to the start of fiscal year 2012). As noted in E24, CG-6 and CG-7 focused on creation of alternative plans rather than identifying funding sources. This approach was a viable method given lack of visibility on funding in general due to the federal continuing resolutions experienced during the year.

In October 2011, non-delivery of MASI 2.0 (E31) was not a surprise, given schedule extensions had been requested of senior leadership in June 2011. Given unknown 2012 funding, MASI development goals should have been altered in the second half of 2011 (Proposition C). A reduction in scope would have allowed fielding of a reduced system in 2011 in the event 2012 funding was not forthcoming. Lack of meaningful focus on identification of funding led to E33,

direct competition for funds between WK and MASI (Proposition A). Certainly at this point the portfolio view should have been considered (Proposition B). WK required MASI to supply IOP functionality, and non-funding of MASI would hurt WK. The two systems competing for funds was entirely nonsensical, yet each side (CG-9333 versus CG-7/CG-6) felt they would be the beneficiary, and alternative funding was not seriously sought until December 2011. WK was a congressionally mandated system, and received the 2012 funding.

Non-delivery of MASI 2.0, and lack of identified funding, led the CG-9333 PM to explore alternatives to MASI (E35) which he was then approved to implement (E37). Although CG-761 provided interim funding in January 2012, to fund the MASI team until the end of February (E38), it was too late (Proposition A). The lack of visibility and conflict with CG-9333 crippled the MASI team, and 55 percent of the OSC team departed (E39). Continued MASI development was no longer practical and the team was dissolved (E40). Although senior leaders were aware of funding issues with MASI and WK, they did not meaningfully intervene or identify alternate funding in a timely manner. Furthermore, they did nothing to reduce the scope of MASI in 2011 to allow fielding of a reduced system (Proposition C).

F. COMPOUNDING COMPLEXITY: FACTOR INTERACTION AND CONTAGION

1. **Proposition A**: As IT portfolio complexity increases, so does the episodic possibility of contagion, amplified by insufficient funding clarity, unresolved capacity problems, and unregulated clan control issues.
2. **Proposition B**: Lack of explicit organizational controls and periodic executive attunement to implicit factors, allows excessive latitude in middle manager's project influence, which may be clan-oriented and contrary to portfolio goals.
3. **Proposition C**: Perception of the periodic influence of organizational factors by portfolio executives is insufficient: In the absence of timely mitigation efforts, minor contagions may compound and amplify, resulting in project cancellations and adverse portfolio impact.

Throughout the analysis in this chapter, the examples cited have shown that as complexity increases (complex network problem), so does the potential for negative effects to the program (schedule, cost, and scope) as well as to the overall portfolio. Analysis of each implicit factor in the preceding sections was difficult to present without referencing the contributions of the other factors because they tend to reinforce each other and propagate throughout the project, program, and portfolio. The result of a series of effects can be difficult to predict, and difficult to analyze, even with the benefit of hindsight. Effects not only amplify and propagate, they can damage the source program as well as the infected one (reciprocal effects).

As noted in Chapter II, Section E, Allen and Gale (2000) discuss the theory of small financial sector shocks spreading to larger areas by contagion. Shaver (2006) referenced increased vulnerability to shocks due to increased interdependencies of merged businesses. The analogous situation occurred with WK and MASI. Each was a complex system dependent on the other. MASI was to provide WK IOP functionality, although it was also a separate enterprise system supporting a non-WK user group. OSC and C3CEN were expected to develop interoperability and data sharing between the two systems. CG-9333 and MRTO teams were dependent on each other for program requirements. WK was tied financially to MASI via CG-9333 funding in 2011, and competition for funds in 2012 (Proposition A). The EOC group was comprised of several peer directorates, who made communal decisions. Lack of well understood organizational controls and insufficient senior leadership action allowed middle managers with provincial views to make critical decisions (Proposition B). Senior leadership acknowledgement of implicit factors was insufficient to halt contagion (Proposition C). The complex interaction between groups and the contagion involving implicit factors combined to eventually result in cessation of MASI development (E40), and the waste of nearly seven million dollars (explained in detail throughout Appendix A).

One specific example of contagion began with C3CEN, but was itself influenced by CG-9333. C3CEN was a group with persistent and largely unrecognized, or uncontrolled capacity issues. See Appendix A for detailed event descriptions which complement this narration. Events E6, E15, E25, and E32 touch on C3CEN’s capacity issues. E6 was an early indicator to senior leadership that C3CEN was experiencing serious development issues, but the focus was release of WK as a technical demonstrator without recognition of fundamental capacity issues (capacity Proposition A). Continuing capacity issues resulted in E15, non-delivery of the WK AMT tool to MASI, which required it in order to develop the user identification and authentication module.

Event E15 also provides an excellent example of firefighting. The AMT tool was delayed for 10 months, and finally delivered with minimal, insufficient functionality (classic firefighting symptoms). The ongoing delays were a result of CG-9333 middle management continually re-assigning C3CEN developers to put out other fires within the program. The delays of E32 were the result of a CG-9333 prioritization which was necessary because C3CEN had missed delivery on a WK service pack. As fundamental capacity issues remained unaddressed, C3CEN entered firefighting syndrome and remained there for the duration of the program.

CG-9333, CG-761, and CG-741 middle management obfuscated the severity of the problem (Proposition B), and C3CEN experienced continued incremental schedule slips, down-scoping of functionality, and the MASI schedule was adversely affected many times due to dependencies on C3CEN which were missed (Proposition A). See Appendix A for further specific impact descriptions. In this case of firefighting, the capacity issue was within the WK program. The program was so large that firefighting was able to take place among the various WK groups, but it also infected C3CEN programs outside of WK and became an organizational problem (Proposition A). Specifically, resources were taken from the C3CEN Search and Rescue Optimal Planning

System (SAROPS) team to work on WK fires. The author does not have data on the extent to which other C3CEN programs were affected by WK induced firefighting.

Although senior leaders certainly understood C3CEN was experiencing significant problems, they continually attempted to mitigate the specific signs and symptoms, rather than addressing fundamental capacity issues. WK capacity issues became a source of contagion to other portfolio programs. Lack of senior leadership action (Proposition C), allowed the problem to perpetuate throughout the entire program duration, resulting in the situation warned of by Bohn and Jaikumar: "the pressure of a backlog of unsolved problems leads engineers to solve problems not just inefficiently, but badly. As a result, each problem supposedly solved has a chance of creating a new problem, and sometimes more than one" (2000, p. 16).

Full, in-depth narrative of the events in Figures 20 and 21 is not practical, but section G below illustrates the complex interaction of only the first seven events. The description for these events is the most simple available for the program overall. They pre-date MRTO, CG-9333 requirements problems, and funding issues, but even absent these influences the complexity is apparent.

G. RECIPROCAL AND REINFORCING EFFECTS NARRATIVE: CONTAGION

The IOC WK project began with an impression of being behind schedule (organizational slack was eliminated before the project began). The SAFE port act (2006) required IOC establishment within three years (by October 2009) yet the CG did not receive funds until fiscal year 2008 (14 months after passage of the SAFE port act). Definitions of a fully operational IOC were also in flux during this time (GAO, 2012). The magnitude of the IOC project was intimidating and although the CG had two years from initial appropriations to mandated completion, initial decisions were influenced by the sense of time pressure.

The pORD (Event 1) was insufficient for developing a system because it “only provided a very high-level conceptual need, not system specific requirements” (LaSalle, 2013, p. 31) yet this explicit document was the only requirements resource available in 2008. WK Segment 1 began development with this document as the only guide. Time pressure influenced the selection of MHS-Ops (Event 2) as the tool to support the planning and scheduling portion of WK (later to be known as IOP functionality). The hope was the MHS-Ops system would require only a small amount of work to make it suitable for integration into WK (an attempt to conserve capacity while reducing cost and shortening implementation time). When security vulnerabilities and other concerns revealed MHS-Ops as unsuitable at an enterprise level (indeed, unsuitable for continued operation at its current installations) the decision to re-write the tool was made and the MASI project was born (Event 3).

The pORD, however, did not contain sufficient detail to enable meaningful requirements for MASI, so the vague goal became to have the new tool emulate MHS-Ops but with the added ability of port partner integration functionality (though this was only notionally defined as well). Concerns regarding lack of port partner related requirements were identified by the OSC MASI team as early as January 2009, but prompted no action from senior leaders. Emulating MHS-Ops was also a poorly informed decision, because the PM and sponsor were unsure the MHS-Ops functionality was suitable for IOC WK integration and functionality, due to the lack of detail in the pORD. The method by which the two tools would interact and exchange data was undefined but middle managers pressed forward (clan control). Thus, the decision to proceed with development based on the pORD began the infection of WK which was transmitted to MASI.

The MASI team, forced to make design decisions in the absence of meaningful IOC WK integration requirements, decided to bind their tool to the MISLE system rather than creating their own database. This decision (partially informed by the HQ implicit control consideration to limit what was viewed at the time as a proliferation of new databases) would have far reaching consequences

as well. MASI 1.0 was originally scheduled to move to production in December 2009. In August 2009, TISCOM disqualified the method by which port partners were to gain access to MASI, in effect making it useless to WK (Event 4). An alternate proposal for port partner access by the MASI team was denied due to lack of WK requirements (an implicit control decision by CG-635). Partially due to the MASI failure and partially due to other WK development problems, what CG-9333 desired to be the first production release of WK was deemed insufficient (no ATO to be granted). The program was forced to deploy only as a “technical demonstrator” (7 months after the date mandated by the SAFE port act) without planning and scheduling functionality (Event 6).

Having failed to enable port partner functionality, MASI 1.0 was tested at Sector Seattle in July 2010 to determine if it could replace MHS-Ops for CG use. Although introduction of a new tool to replace a well-liked tool is challenging, MASI 1.0 failed in its test deployment largely due to issues created by its close coupling with the MISLE system (Event 7). MASI 1.0 was never officially released on the recommendation of HQ middle management.

The decision to begin with the pORD as the primary source of requirements infected both the initial WK and MASI development efforts. In conjunction with perceived time constraints, this resulted in the essential failure of the initial version of both tools. This is an example of a reciprocal effect, where insufficient WK requirements contributed to MASI 1.0 failure, which then contributed to the WK failure to obtain an ATO. The impact to the MASI team was severe as well. MASI 1.0 was generally considered a technically sound tool, which was well implemented, but built with what turned out in hindsight to be incorrect requirements. Twenty months of full team development were perceived as largely wasted and morale on the team suffered greatly. Although the ORD was finished in March 2010, and was much more robust than the pORD, it was also a high-level conceptual document (Event 5).

Several other examples of adverse reciprocal and reinforcing effects may be sussed out from the descriptions in Appendix A, in conjunction with Figures 20 and 21.

H. SUMMARY

This chapter, in conjunction with Appendix A, forms the bulk of the WK and MASI case study analysis. Specific examples were given to support the assertion that WK was a program which experienced significant problems spanning the time frame of the study. The analysis of events, including the event matrix diagram and event flow diagram, were explained and detailed. Relevant statistics were presented, revealing significant effect from implicit factors, and several themes emerged. The themes were organized into propositions regarding capacity, control, funding priorities, and their interaction. Finally, the first seven events were explained in a narrative style to illustrate an example of factor interaction, and reciprocal effects.

V. CONCLUSION

Information Technology (IT) projects have a well-documented potential for complexity, difficulty, and failure. This thesis utilized a case study to demonstrate success or failure depends not only on the individual project but also on the dynamic interaction of organizational factors at the portfolio level. With MASI 1.1, the OSC development team achieved success by creating a tool that not only served the mission needs of its user base, but was also well-liked and easy to use. The team won the OSC “Team of the Quarter” award for its efforts (detailed in Appendix C). Yet this same team failed to deliver MASI 2.0 on schedule and saw all development discontinued. The difference in the efforts was the increasing entanglement and dependency upon the unhealthy WK program in conjunction with organizational factors limiting time, scope, and quality. Enterprise IT projects are not developed in a vacuum, and WK problems infected MASI as well as other systems in the portfolio.

Through event analysis, several themes emerged which emphasize the potential impact of implicit factors on portfolio programs, particularly in and among complex organizations. The recommendations below put forth strategies to help prevent and mitigate undesirable shocks to the portfolio from the factors discussed, as well as how to identify their effects and limit their influence.

A. RECOMMENDATIONS: MANAGING ORGANIZATIONAL FACTORS FOR PORTFOLIO SUCCESS

Large organizations and the accompanying enterprise IT architecture which complements its business goals, continue to increase in complexity. Awareness of organizational factors which affect the IT portfolio is increasingly critical, yet awareness alone is insufficient. Table 4 selects a key recommendation for each implicit factor for three broad levels of hierarchy: Senior leaders, middle managers, and project managers. The sections below elaborate on the recommendations.

Table 4. Recommendations: Managing Organizational Factors For Portfolio Success

	Recommendations for *Capacity*	Recommendations for *Control*	Recommendations for *Funding Priorities*
Senior Leaders	Complete a portfolio review prior to large influxes of work	Create a non-punitive vertical reporting structure and cultivate both vertical and horizontal implicit control networks to supplement explicit authority	Clear communication and transparency should accompany timely prioritization decisions
Middle Managers	Actively seek out and report firefighting trends	Understand and align with portfolio goals, providing honest vertical reporting	Resist local continuation efforts at the expense of the portfolio
Project Managers	Differentiate between project problems and organizational firefighting	Be aware of implicit control networks, and utilize them when necessary to further organizational goals	Provide honest milestone reporting and expect timely notification of prioritization decisions

1. Systematic mechanisms for understanding and mitigating capacity problems at an organizational level are critical to avoid compounding project delays and portfolio impact.

Senior Leaders: Due to the invisible nature of capacity issues, recognition can be difficult. When the portfolio is healthy, actively guard against capacity issues. Perform a portfolio review prior to approving commencement of large new projects. This will not only identify possible overlap of a new system with existing ones, but will also show the current status and staffing profiles of existing projects. Be vigilant for signs of organizational firefighting, particularly following commencement of new projects or when experiencing an influx of work. Dashboard style reporting systems favored by senior leaders are helpful, but depend on input from both middle managers and project leaders. Create a non-punitive reporting atmosphere to encourage honest reporting from middle managers. Transparency in leadership is critical, and the development organization should periodically receive training to enhance understanding of organizational goals. Do not force project managers to eliminate all slack time from project plans. Do not expect to force changes to an aspect of the project management triangle (scope, funding, or schedule) without allowing corresponding shift of the other elements. Organizational firefighting syndrome is

difficult to mitigate when in progress. Bohn and Jaikumar (2000) detail tactical and strategic changes for immediate, short term mitigation, but cultural changes are typically required for eliminating the problem and preventing recurrence. In the thesis case study, cultural elimination of slack time, and constant budget slashing to obtain short-term savings, contributed to long term capacity issues.

Middle Management: Consolidate reports from project managers, actively searching for insufficient capacity or firefighting trends. Report problems without fear of repercussion. Particular attention should be exercised in cases where personnel are being removed from projects under development to take on new work. Understand portfolio goals and resist local optimization at the expense of the portfolio. Expect meaningful intervention and prioritization from senior leaders. Do not force removal of slack time from project manager plans.

Project Manager: Differentiate between project problems and organizational capacity issues. Report issues to middle management in a timely manner and expect meaningful intervention. Clearly document project delays believed to have been caused by capacity issues or organizational firefighting. Insert reasonable slack time into project plans and expect support from middle management.

2. **Prudent use of implicit control by senior managers can greatly increase the chance of success and bridge clan divides.**

Senior Leaders: Do not discount the importance of implicit control networks. It may be tempting to dismiss implicit control concerns as "playing politics," but this is not the case. Foster creation of implicit control networks with fellow senior leaders and middle management of parallel organizations (departments or units) to unofficially bridge clan divides. Seek to use implicit control to supplement explicit hierarchical authority, and as a method to receive reports on portfolio health outside of official channels. Create a forum where middle management can discuss portfolio goals without repercussion, to encourage honest reporting and exploration of ideas. Implicit control should not imply duplicity or deception, but is merely an alternate or supplemental method to

achieve organizational goals. A senior leader who utilizes both explicit and implicit control has an advantage over those who don't.

Middle Management: Seek understanding of the portfolio and organizational goals, and help ensure alignment with projects. Discuss perceived gaps with senior leaders and provide supporting evidence. Do not use implicit control to implement an agenda contrary to the policies of the organization (department or unit).

Project Manager: Be aware of implicit control networks. Support and understand organizational goals. Seek to officially work through middle managers and direct superiors, but maintain alternate unofficial lines of communication with senior leaders when possible. A redundant implicit control network can work to minimize the adverse effects of an incompetent middle manager.

3. Following identification, realistic assessment of funding priorities at the project level must inform timely changes to scope, schedule, and quality.

Senior Leaders: When creating funding priorities, avoid favoritism and promote transparency. Sound funding priorities should be defensible under scrutiny and align with organizational goals and the overall IT architecture. No project should be considered "too big to fail." Ensure program milestones are meaningfully met. When possible, resolve funding priorities expediently. Do not allow a project to continue at unsustainable levels when further funding is not available. If projects must be truncated or cancelled, timely notification allows for graceful project resolution and archiving of data for possible future use.

Middle Management: Do not obfuscate or alter project reports to senior leaders to disguise problems. Provide honest evaluations of projects, particularly at critical milestones. Timely identification of unhealthy projects allows for thoughtful mitigation and prioritization. When a project must be downsized or altered, report the information in a timely manner to the project manager. Allow time for project members to seek reassignment within the organization, if possible. Do not be tempted to identify local methods to enable project

continuance without approval from senior leaders in accordance with organizational goals.

Project Manager: Support project status reports and milestones faithfully. Do not attempt to manipulate data or figures to shelter a specific project or development team. Resist clan control at the expense of portfolio goals. Unhealthy projects must be identified in order to assess their continued value to the portfolio. Expect timely and honest feedback from middle managers regarding project status in the portfolio.

4. Summary

An experienced leader may argue many of the recommendations are not always possible or practical to implement. A situation, in which total alignment exists from senior leader to the engineer working on a project, is rare. Transparency through levels of hierarchy is beneficial to promoting understanding of organizational goals, but is rarely understood by all. A complex organization may not explicitly afford an individual at a certain level of hierarchy to implement sweeping changes (at this point, faithful readers of the thesis should be considering implicit control networks). If nothing else, awareness of the effect of organizational factors on IT portfolio management and development will aid a good manager or leader in performance of their duties, and in the guidance of those below them.

B. RECOMMENDATIONS FOR THE USCG

Implementation of the recommendations proposed in Section A would benefit the CG, but additional specific actions would also be beneficial.

An extensive review of the SDLC and MSAM/SELC processes, along with clarification of responsibilities between CG-6 and CG-9 would help limit the influence of implicit factors. The processes were designed to aid implementation and lifecycle management of quality IT systems, but are only meaningful when followed. As evidenced by event E18, statements regarding obfuscated

milestone reporting (LaSalle, 2013), and various requirements issues, the SDLC and MSAM/SELC processes are often circumvented or marginalized.

The COEs (particularly OSC and C3CEN) view themselves as individual clans, a view which is reinforced when they compete for funds. They have areas of overlapping responsibility which have allowed redundant development. Individuals working in redundant areas exhibit extreme clan behavior in an effort to preserve their positions. Leaders of the COEs resist what they see as loss of mission to their rival COE. These attitudes inhibit cooperation and do not support portfolio or business goals. One current example is overlap in geographic information systems development between OSC and C3CEN. Although the COEs were re-organized under the C4IT SC, little meaningful effort has been made to bridge the clan divides. Either the COEs should be merged in some manner, or their areas of responsibility more clearly separated. This would be a contentious process as each COE would resist the changes, but would result in a more streamlined and efficient organization.

The clan problem is also reflected at higher hierarchical levels. As budgets continue to shrink, CG-6 and CG-9 have begun to compete for scarce resources. This reinforces clan behavior at the expense of the CG mission and IT portfolio. Senior management should lead by example in promoting cooperation, rather than competition, between directorates. Focus should be placed on organizational goals with a supporting IT architecture, not in maintaining directorate power and structure at the expense of the mission. A cultural shift to realign focus may be necessary.

Finally, the prevailing attitude in the CG of “doing more with less” is often accompanied by capacity issues, decreased product quality, and cost and schedule overruns. A more realistic attitude would be to mitigate capacity issues by realistically adjusting the amount of work and number of projects in progress at any one time.

C. SUGGESTIONS FOR FUTURE RESEARCH

Further studies using the lens of organizational factors and contagion theory in IT portfolio development would support the efficacy of the theory, particularly studies performed on private sector organizations.

Related studies which increase the focus on the implicit activities of middle managers and associated impacts would increase understanding in this area and contribute to the body of knowledge touched on in such works as "In Praise of Middle Managers" (2001) and "Emotional Balancing of Organizational Continuity and Radical Change: The Contribution of Middle Managers" (2002), both by Quy Nguyen Huy.

An area of research complementary to the framework prevented in this thesis involves the study of "tensions." Organizational factors create tension between project and portfolio concerns, as well as management of projects versus management of portfolios. Several articles have begun to explore this idea, including: "Toward a Theory of Paradox: A Dynamic Equilibrium Model of Organizing" (2011) by Smith and Lewis.

For the CG, according to interviews with several individuals in CG-9333, CG-761, CG-633, and C3CEN, the ambiguities between SDLC and major acquisitions have not been resolved. The time frame for the thesis case study concluded in February 2012, prior to WK final development and production release. Further study of the WK program would be pertinent to the issues raised in this study. Following WK independence from MASI, did their problems continue, and why? Were capacity issues and firefighting addressed? Given its limitations, how was the WK system received by end users? A study which focused on the capacity and control issues involving C3CEN would be illuminating. Such a thesis would form a trilogy of theses involving the WK system. LCDR LaSalle (2013) addressed agile development and to a lesser extent the HQ middle management perspective, while this thesis addressed portfolio concerns and focused on the OSC and MASI perspective.

Lessons would also be learned from other long-running and troubled CG development projects including the Vessel Documentation System (VDS) which took seven years, and the Marine Information for Safety and Law Enforcement (MISLE) version 5.0 which has surpassed five years. Preliminary analysis by the author suggests they have been negatively affected by implicit organizational factors and portfolio issues in a manner similar to WK and MASI but further analysis may reveal additional complexities.

An exhaustive study of both C3CEN and OSC to fully detail areas of overlapping development, as well as how conflict and cooperation have affected the development of various enterprise systems, would be illuminating. The framework developed in this thesis would present an excellent starting point for analysis of the two COEs.

APPENDIX A. DETAILED WK AND MASI EVENT LIST

1. E1: IOC WK pORD Published

- Description: The pORD document was put together by CG-635 and CG-761. By design, it provided a notional, very high level conceptual need. It was not system specific, and was insufficient for system development, yet it was used by WK for exactly this purpose due to explicit time constraints. The SAFE Port act of 2006 mandated IOC establishment within three years, but appropriations for the program were not received until 14 months later, creating time pressure.
- Event Type: Explicit
- Severity: 3
- Impact: Time: Pressure due to a late start relative to the SAFE Port Act requirements (14 months of 3 year period) caused commencement of design without proper requirements
- Occurrence Time Frame: April 2008

2. E2: MHS-Ops Selected to Fulfill WK IOP Functionality

- Description: MHS-Ops was a siloed mission and asset scheduling system deployed at several CG sectors. The CG-9333 PM hoped MHS-Ops could be used by IOC WK with minimal additional development work, thus saving time and funds which could be applied to other WK functionality.
- Event Type: Implicit
- Implicit Category: Funding Priority
- Severity: 2
- Impact: Time/Cost Avoidance: Unrealized
- Occurrence Time Frame: October 2008

3. E3: Re-write (MASI Creation) and Discontinuation of MHS-Ops Mandated. Port Partner Access Critical

- Description: After a technical evaluation, MHS-Ops was determined not only insufficient as an enterprise tool, but a security risk at CG locations where it was used. CG-6 prioritized creation of a replacement for MHS-Ops for CG users (MASI). Specific written requirements did not exist other than to "emulate MHS-Ops" and introduce Port Partner access for future WK users. Unfortunately,

both proved problematic. Due to the siloed nature of MHS-Ops, it had been uniquely modified by each sector at which it was used. Methodology to allow Port Partner access was only vaguely defined by the pORD.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 5
- Impact: Time/Cost: Order of magnitude for entire OSC MASI development effort was ~$6.5M in just over three years. E2 had hoped for minimal cost and MHS-Ops use. The cost does not include effort by CG personnel. MASI was not part of the original IOC WK plan
- Occurrence Time Frame: November 2008

4. E4: MASI 1.0 not Accessible by WK Port Partners

- Description: Port partner access to MASI was briefed as a high risk in January 2009, due to lack of requirements. Under significant schedule pressure (motivated by the directive to replace MHS-Ops), the MASI team designed a Port Partner access solution, permission for which was rescinded in August 2009, by TISCOM. TISCOM determined port partner access to the CG Data Network represented a security risk. The MASI team attempted to salvage the situation by moving the system to the DMZ, but this was denied by CG-635 (part of an implicit control confrontation with CG-9333), also due to lack of requirements. No other solution was practical given the December 2009 production release date. MASI 1.0 was unsuitable for integration with WK.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 8
- Impact: Cost: $150k estimated OSC MASI development resource wasted on the port partner solution. Critically contributed to E6
- Occurrence Time Frame: August 2009

5. E5: IOC ORD Published

- Description: Although much more robust than the pORD, this document also presented high level operational requirements, insufficient for system design. The document lists WK “Initial Operating Capability” date of Q4, 2011.

- Event Type: Explicit
- Implicit Category: n/a
- Severity: 3
- Impact: Time: C3CEN WK development lagging due to prior lack of requirements documents
- Occurrence Time Frame: March 2010

6. E6: WK Insufficient for Production Release, Approved for Release as Technical Demonstrator Instead, without MASI

- Description: Release as a technical demonstrator was not in the WK plan and was a last resort to enable continued deployment after an authority to operate (ATO) was denied due to lack of functionality.

> Initially, the [WK] developers broke the requirements into three spiral deliverables. The first spiral would deliver eight percent of the requirements, the second spiral was slotted to deliver 12 percent of the requirements, and the third spiral would deliver the remaining 80 percent of the requirements. After missing the delivery date of the first spiral by 114 days, the developers reduced the targeted scope by 50 percent and added five additional spiral releases. (LaSalle, 2013, p. 52)

Further, the GAO noted:

> In September 2009, the Coast Guard released initial WatchKeeper capabilities to Sector Charleston, South Carolina. However, in March 2010, an operational test and evaluation revealed limitations in the maturity of the technology. As a result, the Coast Guard halted further deployment of WatchKeeper to additional IOC locations. In May 2010, DHS authorized the IOC project to release WatchKeeper as a technology demonstrator to all 35 IOC locations. (2012, p. 18)

This decision removed many MSAM requirements from WK, but came at the expense of reduced funding and operational backlash (LaSalle, 2013). In reality, the CG had hoped to release WK as a production system, but succumbed to the technical demonstrator option under pressure from DHS (implicit control).

- Event Type: Implicit
- Implicit Category: Control
- Severity: 4

- Impact: Cost: Reduced funding and operational backlash for WK. Exact amount of funding reduction unknown, although in the millions
- Occurrence Time Frame: May 2010

7. E7: MASI 1.0 Test Deployment Failure at CG Sector Seattle

- Description: Following the failure of MASI 1.0 to enable port partner access for WK, the pressure to succeed as a replacement for MHS-Ops in CG use was intense. The July 2010, test deployment to CG Sector Seattle was to determine if MASI 1.0 was suitable. The effort was a failure on several fronts. In an effort to standardize business processes across the CG, CG-761/CG-741 altered them and did not inform or prepare users prior to MASI deployment. Users expected identical functionality and resented the changes. Critical design decisions were made by CG-761/CG-741 which in retrospect were ill- advised. MASI 1.0 directly connected to CG MISLE in a way which made system use impractical. Although CG-761/CG-741 could have pressed for release of MASI 1.0 and corrected issues in later releases, they labeled the system a failure. This frustrated CG-6 because they were under pressure to discontinue MHS-Ops. Tension between CG-6 and CG-7 at senior levels ensued and implicit control struggles hampered further MASI direction and strategy. Although MASI 1.0 was a victim of incorrect requirements, the product was technically competent. The development team had put forth an incredible effort and the failure to release the system drastically lowered team morale.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 8
- Impact: Cost/Time: OSC MASI team, ~$2M in development wasted over 18 months
- Occurrence Time Frame: July 2010

8. E8: Executive Oversight Council (EOC) "Getback" Meeting

- Description: This critical senior level meeting (CG-6, CG-7, CG-933, OSC, and C3CEN) was in response to the recent failures of both WK and MASI. At a high level, several touchpoint events were identified between MASI and WK, with projected completion dates. Unfortunately, the MASI development team was not consulted prior to delivery promises made on its behalf (an event so significant it

was separately noted as E11). In addition, the MASI project was underfunded, with only 3 months of development funds available for 2011. The meeting illustrates a significant lack of understanding by senior leaders of the complexity and scope of the WK and MASI systems, and the complexity of their unresolved dependencies.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 4
- Impact: Scope/Cost: High level WK/MASI touchpoints scheduled. MASI only 25 percent funded for 2011
- Occurrence Time Frame: October 2010

9. E9: IOC APG Published

- Description: The purpose of the Interagency Operations Center (IOC) Acquisition Project Guide (APG), written by CG-9333, was to define the relationships between WK major project elements. The guide also communicated the strategic goals of the project and aligned the responsibilities of each project element to those goals. Among the glaring omissions from the document are any mentions of MASI, or of interoperability, or acknowledgement of OSC as a developmental project element. This reflects the explicit disconnect between CG-9333 major acquisition processes and CG-6 IT processes
- Event Type: Explicit
- Implicit Category: n/a
- Severity: 2
- Impact: Time: Re-baselined WK timelines according to E8, in response to E6
- Occurrence Time Frame: October 2010

10. E10: MRTO Created

- Description: Due to widely recognized requirements gaps, the CG-9333 PM provided funding to OSC for creation of a MASI requirements team (MRTO). The original planned duration was 9 months. The requirements terminology from high level to low was “operational,” “functional,” and “system.” From the OSC point of view, the team was to identify MASI business processes and derive system requirements from the very high level ORD and FRD (yet to be delivered), and create requirements for WK/MASI interconnections. Normally, CG-761 and CG-741 would have

gathered end-user requirements and presented them to the MASI team. Capacity issues prevented this from being completed in a timely manner, a common HQ middle management problem. In addition, the OSC contractor responsible for staffing the MRTO team experienced difficulty hiring business analysts. The team was half-staffed for three months.

- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 5
- Impact: Cost: $470k for a four person team over 9 months. Not part of the original IOC WK plan
- Occurrence Time Frame: October 2010

11. E11: EOC Mandated October 2011 MASI 2.0 Development Completion

- Description: Referenced in E8, this was the most egregious requirement from the “EOC Getback” meeting (from the MASI point of view). The OSC MASI development team was asked for a MASI 2.0 development estimate based on the high-level, vague requirements available. MASI 2.0 was to support WK IOP functionality and incorporate port partners. The MASI team estimate was 18 months. The EOC ignored the technical estimate and mandated a 12 month schedule with no funding increase (an arbitrary 6 month, 33 percent cut). The unrealistic deadline was designed to coincide with IOC WK Segment 2 SELC activities and milestone reviews, which were later delayed, though a corresponding MASI delay was not allowed until much later. The deadline was a great source of frustration to the MASI development team who were expected to commence development without system level requirements. To mitigate the capacity issue created by the restricted timeline, the idea of "baseline requirements" for MASI 2.0 were created. The OSC MASI project team invested significant time convincing middle management and senior leaders of the necessity of the scope reduction. Full implementation of IOP requirements (in as much as they existed) was not possible in the truncated time frame.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 8
- Impact: Time/Scope: 33 percent compression of MASI 2.0 development schedule forced eventual re-baseline of scope

- Occurrence Time Frame: October 2010

12. E12: CG-633/CG-761/CG-741 MASI 1.1 Prioritization Decision

- Description: Given the MASI 1.0 non-release after the deployment failure at Sector Seattle, CG-6 re-emphasized replacement of MHS-Ops (originally scheduled for shutoff in Aug, 2010). The MASI team was forced to shift focus away from MASI 2.0 (for WK) in favor of the internal CG user. MASI 1.1 Development officially began Nov 3, 2010 and ended Feb, 22, 2011 on schedule. A follow on minor update, MASI 1.1.1 was released in April. The MASI 1.1 effort was a resounding success, at the expense of MASI 2.0 development, the schedule for which had already been drastically shortened in E11.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 5
- Impact: Time: Delayed MASI development team focus on MASI 2.0 for WK by 4 months (25 percent of the 12-month truncated schedule from E11)
- Occurrence Time Frame: November 2010

13. E13: IOC FRD Published By CG-9333 Subcontractors. CG-9333 Attempts to Control and Limit MASI Requirements Generation

- Description: The IOC functional requirements document (FRD) was created by Booze Allen Hamilton (BAH) (contractor) in conjunction with CG-9333, with assistance from CG-741. The MRTO team had been told the document would enable direct decomposition of functional requirements into system requirements suitable for the MASI development team but this was not the case. The FRD contained critical gaps, but was vigorously defended by CG-9333 in an effort to maintain clan credibility. CG-761, CG-741, and MRTO were forced to prove the gaps in E22, experiencing significant delay.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 4
- Impact: Time: Four month delay for the MRTO team as they were forced to significantly add to this document (E22) while dealing with significant CG-9333 resistance
- Occurrence Time Frame: November 2010

14. **E14: Power and Control Struggles Begin at Initial MRTO and Stakeholder (CG-9333, CG-761, CG-741, C3CEN, and OSC) Meeting**

- Description: CG-9333 had made several statements regarding control of the requirements process to the MRTO team prior to the joint kickoff meeting. CG-9333 and CG-761/CG-741 representatives immediately clashed, and CG-761/CG-741 departed the meeting after 15 minutes. The domineering attitude established by CG-9333 established the tone going forward. They insisted the FRD was sufficient to generate MASI system level requirements and attempted to directly control MRTO team activities. They were very sensitive to comments suggesting requirements were incomplete.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 6
- Impact: Time/Scope: See E13 impact. In addition, developer time and CG personnel time was invested
- Occurrence Time Frame: December 2010

15. **E15: AMT Non-Delivery by C3CEN**

- Description: The failure to deliver the Account Management Tool (AMT) by C3CEN was the first overt indication of capacity problems which impacted MASI. The MASI team required the AMT in order to design MASI functionality to authenticate and authorize WK port partner entry to the tool. After many delays, C3CEN delivered the AMT 10 months late without required functionality. The AMT delay was the result of CG-9333/C3CEN clan control, caused by capacity issues. CG-9333 was sensitive to schedule delays which continued to plague C3CEN, and did not prioritize the AMT on-schedule development because it was not perceived to be as visible as other delays. They prioritized C3CEN work to obfuscate capacity issues to senior leadership. Consideration of MASI was a secondary concern, because they saw MASI as a separate clan. This shortsighted outlook contributed significantly to delays in WK/MASI interconnection requirements and is an example of CG-9333 middle management latitude being utilized in a manner contrary to portfolio goals. When allowed by CG-9333, C3CEN and OSC development teams worked well together. After rearranging the development schedule several times, the MASI team was forced to design their half of the AMT interface based on what they guessed the WK AMT tool might do.

- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 6
- Impact: Time/Scope: The OSC MASI development schedule was re-written to delay development of MASI modules which required AMT. The eventual AMT delivery was unusable by MASI. Ensuing churn over the course of repeated non-delivery and associated meetings was 1 month
- Occurrence Time Frame: January 2011

16. E16: CG-9333 Provided Nine Months of MASI Funding for 2011 Development

- Description: The CG-9333 PM verbally agreed in July 2010 to fund 9 months of 2011 MASI development (MASI 2.0) specifically to satisfy WK requirements. The PM stated at this time WK would have no further funds to supply for 2012. Funding from this source was not ideal because it further reinforced CG-9333 implicit control over MASI requirements and schedule.
- Event Type: Explicit
- Implicit Category: n/a
- Severity: 4
- Impact: Cost: CG-9333 directly and indirectly provided ~1.4M for OSC MASI 2.0 development in 2011. This cost was not part of the initial CG-9333 WK plan
- Occurrence Time Frame: January 2011

17. E17: MASI 1.1 Deployed, Users Happy. CG-761/CG-741/CG-633 Delay Official Release

- Description: As stated in E12 MASI 1.1 was a success. The Deployable Operations Group (DOG) was the primary user of MHS-Ops, and they provided specific requirements to the MRTO and MASI development teams which were used to create the tool. Several in-progress demonstrations were held for DOG representatives, which were favorably received prior to final completion. Although DOG accepted the tool in March 2011, and began to use it, CG-761 did not authorize official production release.
- Event Type: Explicit
- Implicit Category: n/a
- Severity: 8

- Impact: Time: Delayed development focus on MASI 2.0 for WK by 4 months (25 percent of the 12-month truncated schedule from E11). (E12 and E17 bookend OSC MASI 1.1 development)
- Occurrence Time Frame: March 2011

18. E18: MASI 1.1 SDLC Documentation Incomplete

- Description: MASI 1.1 was not officially released in March in large part because CG-633 did not complete the required SDLC documents. CG-633 middle management was experiencing significant capacity issues, and documentation was not prioritized. The documents were eventually created by July 2011 but by then CG-761/CG-741 had decided not to release MASI 1.1 beyond DOG use. Although the SDLC process was not properly followed by HQ, MASI 1.1 enabled the shutdown of MHS-Ops.
- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 5
- Impact: Time/Quality: CG-633 delayed document completion for 4 months
- Occurrence Time Frame: March 2011

19. E19: WK Does not Add Link to MASI 1.1 Contrary to EOC Mandate

- Description: In March 2011, CG-761/CG-741 were supposed to allow C3CEN to place a link to MASI 1.1 on the WK tool bookmark page. This would have allowed CG WK users to use MASI 1.1. The CG-9333 PM requested this functionality as the initial link between WK and MASI (and was also mandated by E8), but CG-761/CG-741 used the lack of SDLC documentation from CG-633 as a way to delay the request. Following completion of SDLC documents, CG-633 pushed for the link to be placed on WK, but after further delay CG-741 officially decided not to release MASI 1.1 for users other than the DOG. The primary reason for the decision was the ill-informed choice made in MASI 1.0 to tie the system to MISLE: A MASI user required a MISLE account for multiple units which was not practical. MASI 2.0 was to eliminate this requirement via the AMT and disconnection from the MISLE system.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 4
- Impact: Time/Quality: MASI 1.1 link never added to WK

- Occurrence Time Frame: March 2011

20. E20: MRTO Team Restricted by CG-9333

- Description: The CG-9333 PM requested a BAH member to serve as a requirements subject matter expert and to help coordinate between C3CEN (WK) and OSC (MASI) as necessary. CG-9333 felt data and business process gathering from CG Sectors was exhaustive. They felt any questions regarding process requirements could be answered by BAH or CG-9333. They placed extreme restrictions on MRTO interaction with end users. MRTO research relating to back-end system requirement gathering and definition were still deemed necessary (C3CEN, ALC/ALMIS, etc.) but controlled by CG-9333. CG-633, CG-761 and CG-741 were at odds with CG-9333 regarding their restrictions on requirements gathering. Although CG-9333 insisted the MRTO team interact only with them, they did not have answers for many questions. The MRTO effort was minimally tolerated by CG-9333 middle management, rather than embraced, delaying progress and minimizing MRTO effectiveness.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 5
- Impact: Time: 4 month delay for MRTO team as they were forced to significantly add to the FRD (E13, E22) while dealing with significant CG-9333 resistance which caused further delay of 2 months, additively over time)
- Occurrence Time Frame: 2011

21. E21: CG-761/CG-741 Do not Approve MASI 2.0 Functional Requirements

- Description: The deadline mandated in E11 required reducing the scope of MASI 2.0 (see Figure 4: Project Management Triangle). CG-761/CG-741 middle management agreed to provide high level MASI 2.0 baseline requirements in March 2011, for MRTO to focus on decomposing to system level requirements. CG-761/CG-741 did not deliver. The high level MASI 2.0 subset of requirements was not approved until May (more than two months later) following a proposal of the requirements from OSC. The reluctance of CG-761/CG-741 to formally approve functional and system level requirements would plague the project until its termination. This was a reflection of capacity issues at CG-7, implicit control difficulties with CG-9333 middle management, and gaps in the IOC

ORD and FRD. Put simply, the business processes which BAH claimed to have mapped, were incomplete.

- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 4
- Impact: Scope/Quality
- Occurrence Time Frame: March 2011

22. E22: Conflict Over FRD 1.1 Content Between CG-7 and CG-9333 Further Delays Creation of System Level Requirements

- Description: Dysfunction between HQ middle management continued when incorporating MRTO feedback into the CG-9333 FRD. MRTO, CG-761, and CG-741 stated the FRD contained too many gaps to allow decomposition to MASI system level requirements. CG-9333 disagreed stating the FRD was complete. This forced MRTO to spend nearly 4 months mapping out gaps, rather than decomposing the FRD. CG-9333 finally admitted the gaps when MRTO identified 75 new Functional Requirements for a 163 percent increase in IOC Interagency Operational Planning (IOP) requirements. New functionality included replacement of the security model, a binary attachment service, and implementation of claims based modeling.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 5
- Impact: Time: 4 month delay for MRTO (see E13, E20) while dealing with significant CG-9333 resistance. Also caused OSC MASI development churn
- Occurrence Time Frame: April 2011

23. E23: C4IT-SC Brief: WK/MASI Concerns

- Description: During this briefing, senior leadership was officially informed of:

1. IOC FRD gaps causing significant delays in decomposing functional requirements.

2. Lack of OSC and C3CEN meetings to define MASI integration with WatchKeeper due to lack of CG-9333 middle management prioritization of C3CEN resources. C3CEN participation was required by OSC to co-develop the integration solution.

3. CG-6/CG-7 were failing to engage other enterprise systems (ALMIS, MISLE, AOPS) to arrange data transfer mechanisms between systems.

No meaningful action was taken by senior leaders following this brief. The first issue was a result of CG-9333 middle management implicit control. The second revolved around C3CEN capacity issues, and the third involved middle management capacity issues at CG-6/CG-7. CG-6/CG-7 capacity issues were creating episodes of firefighting, and they incorrectly perceived system interconnect issues as non-critical at that time. They failed to understand the significant lead time and high-level authorization necessary to place MASI related work in the development schedule of several other enterprise systems.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 3
- Impact: Time/Scope: Briefing on impacts from E13, E20, E22, and warning of future scope issues
- Occurrence Time Frame: April 2011

24. E24: 2012 MASI Funding in Doubt

- Description: CG-9333 had stated in the middle of 2010 it would be unable to provide any MASI funding past 2011. Rather than focusing effort on locating alternate funding sources for 2012, CG-6/CG-7 middle management engaged the MASI team in creation of a myriad of budget projections, based on several different 2012 scenarios. Several scenarios involved cutting team personnel and reducing the scope of MASI. In defense of CG-6/CG-7 middle management, there seemed to be only token support from their superiors who simply ordered them to find solutions. As time progressed, the uncertainty of the program's future impacted MASI planning, team morale, and CG-9333 confidence in an eventual MASI system.
- Event Type: Implicit
- Implicit Category: Funding Priority
- Severity: 7
- Impact: Cost/Scope: Only ~28 percent of OSC MASI 2012 funding had been identified. Extensive scope and personnel (cost) reductions were discussed
- Occurrence Time Frame: April 2011

25. E25: WK does not Utilize MASI 1.2 for WK State of the Port (SOP) Contrary to EOC Mandate

- Description: E8 and E23 show examples of senior leadership awareness of the lack of interoperability between WK and MASI due to lack of prioritization. As mentioned, CG-9333 middle management did not prioritize the capacity-limited C3CEN development teams to perform WK development related to MASI. The failure of the WK State of the Port (SOP) display to incorporate the MASI 1.2 ESB data feed was another example. Senior leaders had mandated WK use of MASI 1.1 and 1.2 in E8. The lack of the MASI 1.1 link on WK was detailed in E19. The MASI team designed 1.2 on schedule and waited for C3CEN to complete their SOP to enable testing of the data service. C3CEN moved implementation from June 2011, to Feb, 2012 (8 months). In November 2011, CG-741 officially decided not to deploy MASI 1.2 until MASI 2.0 went to production. The continual delays, lack of senior leadership support, and disregard by CG-9333 for the OSC team caused MASI schedule churn and morale issues.
- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 4
- Impact: Cost/Time: $100k estimated OSC MASI development resource wasted. Also caused MASI schedule churn which later wasted another month for 1 developer. MASI 1.2 was never utilized by WK
- Occurrence Time Frame: June 2011

26. E26: Change of CG-9333 PM

- Description: The outgoing CG-9333 PM was responsible for funding MRTO, and 9 months of MASI 2011 development, as well as the initial decision to use MASI for WK IOP functionality. Although senior leadership (including the PM) in general disregarded MASI issues, the PM supported MASI integration under WK. As an effort to ensure WK/MASI integration following his departure, the PM wrote an official memo detailing high level MASI 2.0 requirements. Following his departure, however, the inexperienced incoming PM was overly susceptible to mid-level CG-9333 management input. The CG-9333 middle managers had firmly established their clan mentality with an ongoing lack of prioritization for WK/MASI interconnection issues, and restriction and delay of the MRTO mission. Their attitude was transmitted to the new PM who seemed to view MASI as a necessary impediment.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 5
- Impact: Loss of CG-9333 senior level champion of the OSC MASI team
- Occurrence Time Frame: June 2011

27. **E27: MASI Development Team Begins RAD/JAD Methodology** Description: CG-9333 interference in MRTO system requirements generation and the delays caused by resolution of FRD gaps resulted in the OSC development team "catching up" to requirements generation. The team had been designing infrastructure and back end services based on lessons learned from MASI 1.0, but had reached the point where further development could no longer proceed without new system requirements. The prior pseudo-waterfall method was discontinued in favor of the RAD/JAD agile development approach, which focused on defining system level requirements with developer input, immediately before official coding of each MASI module. The effort was also designed to assist the capacity constrained CG-761/CG-741/CG-633 middle management representatives by incorporating their feedback during the JADs. CG-761/CG-741 were responsible for representing users by delivering requirements. MRTO members transcribed requirements created during JADs, but obtaining timely approval of these requirements by middle managers remained a critical problem and source of delays.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 4
- Impact: Time/Scope: New methodology to enable near-concurrent requirements definition and system development
- Occurrence Time Frame: July 2011

28. **E28: Status Brief to Assistant Commandant for U.S. Coast Guard Capability (CG-7 RDML)**

- Description: Another brief to senior leadership which focused on issues involving MASI development. By this time, senior leadership was accustomed to "MASI problems," but the OSC MASI team was rarely the cause of these issues. Although successfully deployed to the DOG, the official MASI 1.1 deployment decision still resided with middle management at CG-761/CG-741. MASI 1.2 deployment (completed by OSC) awaited C3CEN implementation of the WK

portion. MASI 2.0 development (already on an unrealistic schedule) was delayed by resolution of FRD gaps, interference through both CG-9333 action and non-action, and non-delivery of the AMT by C3CEN. The series of shocks to the MASI schedule and team from WK and CG-9333 were visibly affecting the MASI effort. Lack of interoperability requirements between WK and MASI were again highlighted, as well as lack of identification of 2012 MASI funds. MASI 2.0 delivery in October was at risk. Once again, senior leadership made only token gestures at resolution of issues.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 3
- Impact: Time/Cost/Scope: Briefed on impacts from E11-E15, E17-E25, and E27
- Occurrence Time Frame: July 2011

29. E29: MRTO Staffing Issues/MRTO Extension

- Description: Delays in requirements generation prompted MRTO team extension to end of 2011 and slippage of deliverables. Initial staffing difficulties and departure of an analyst allowed the extension to the remaining team under the original funding amount.
- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 3
- Impact: Time: 6 Month MRTO team extension (see E13, E20, E22)
- Occurrence Time Frame: July 2011

30. E30: CG-9333 Pushes for Fundamental Changes in WK/MASI Interconnection (Object Level Linkage)

- Description: The original CG-9333 PM (who departed in E26) had mandated all WK/MASI intersystem connectivity take place via ESB in support of CG policy and given WK technical limitations. CG-9333 middle management finally realized this limitation would impact desired WK user performance. No solution was readily available because interoperability concerns had been repeatedly delayed due to C3CEN capacity issues and lack of CG-9333

prioritization. Clan mentality continued to dominate CG-9333 and reinforced their perception of MASI as a liability.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 6
- Impact: Scope
- Occurrence Time Frame: July 2011

31. E31: MASI 2.0 Non-delivery to WK for Integration

- Description: Delivery of MASI 2.0 in October of 2011 was an artificial deadline created by senior management (E8, E11) when only rudimentary business requirements had been defined. Given no extra resources and a reduced timeline, the MASI team was forced to re-define MASI 2.0 functionality (project management triangle). The delays and issues detailed in E12-E26, and E28-E30 compounded and built upon one another to infect MASI development and made delivery in October impossible. C3CEN had not completed the AMT tool to enable critical MASI development. System requirements were still incomplete in October. By June 2011, WK had delayed planned MASI 2.0 integration until April 2012, yet a corresponding MASI development schedule slip was denied. Although senior leadership had been briefed on the serious issues facing MASI development which were beyond the authority of the MASI team to control, they did not meaningfully intervene. The unjust perception of MASI as a problem project was magnified by this event, although it should have surprised no one. MASI team morale continued to degrade and team members began to resign.
- Event Type: Implicit
- Implicit Category: Control
- Severity: 7
- Impact: Time/Cost: Total OSC MASI development cost from inception to this date was roughly $5.8M. The only system fielded at this time was MASI 1.1, used by CG DOG. WK had not created the AMT, or integrated MASI 1.1 or 1.2, and 2.0 was not delivered (for reasons described in E11-E15, E20-E23, and E28-E30)
- Occurrence Time Frame: October 2011

32. E32: CG-9333 Directs WK/MASI Technical Interface Meetings be Delayed Until December 2012

- Description: Although many MASI issues were directly and indirectly influenced by CG-9333 middle management decisions, non-delivery of MASI 2.0 was interpreted by the CG-9333 PM as OSC MASI development team unreliability. He began to influence CG-741 senior leadership with this view. WK (C3CEN) was once again late with a service pack delivery (capacity) and CG-9333, operating on clan control assumptions and engaging in firefighting, further delayed meetings between OSC and C3CEN which would define system touchpoints and interoperability. The AMT and port partner requirements were further delayed, which in turn delayed MASI development of corresponding modules. The CG-9333 PM did not view C3CEN work as superior to that of OSC (given their repeated delays) but he viewed WK as part of his clan and prioritized for them. The WK program had been investigated by the GAO and downgraded from major acquisition status due to sustained capacity and development issues at C3CEN, in large part caused by lack of useable WK requirements from BAH. The downgrade removed further SELC milestone requirements, but impacted WK funding.
- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 5
- Impact: Time/Scope: WK/MASI interconnection definitions and AMT requirements delayed another 6 weeks. Caused further churn to the OSC MASI 2.0 development schedule
- Occurrence Time Frame: October 2011

33. E33: Competition for 2012 Funds Between WK and MASI

- Description: The only funds identified by CG-633/CG-761 middle management for MASI were also claimed by CG-9333 for WK. Global budget cuts and a C4IT-SC fee levied on programs, combined with the lack of funding emphasis by HQ middle management (despite continued warnings from the MASI team which had begun 7 months prior) made the issue critical. The CG-9333 WK acquisition was mandated by congress, and they were certain they would receive the money. For reasons not known to the author, the CG-761 directorate head was certain the funds would go to MASI. Also for unknown reasons, CG-761 middle management broke away from the directive of their superior and influenced the final decision to allocate funds to WK. The true error was in allowing competition for funds between codependent programs. CG-9333 began to quietly investigate alternatives to MASI.

- Event Type: Implicit
- Implicit Category: Funding Priority
- Severity: 9
- Impact: Cost: CG-633/CG-761 on behalf of OSC MASI, and CG-9333 on behalf of C3CEN WK both tried to obtain the same $1.3M for 2012
- Occurrence Time Frame: September 2011-January 2012

34. E34: MASI Status Brief to RDML (CG-7) and SES (CG-6)

- Description: From the senior leadership perspective, this brief again focused on MASI development and release problems. The official decision not to place MASI 1.1 into production (beyond DOG use) was announced (middle management decision),the decision not to deploy MASI 1.2 until MASI 2.0 rolled was announced, as well as failure to complete development on MASI 2.0. The toll on the MASI development team had become critical as they announced a 2 month overall delay due to loss of the senior database designer and a critical middleware developer. The middleware developer was not replaced due to 2012 funding uncertainty. The opinion of senior leadership (with the exception of the CG-761 director) continued to turn against MASI as a viable option, particularly that of the CG-9333 PM.
- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 5
- Impact: Cost/Time/Scope: Briefed events to this point. OSC MASI announced an additional 2 month delay due to attrition of critical team members
- Occurrence Time Frame: November 2011

35. E35: CG-9333, CG-741, and CG-761 Hold "Simple Scheduler" Meetings Without Notifying OSC

- Description: The CG-9333 PM directed his middle management to create an approach that would allow them to officially separate from MASI if given RDML approval. CG-741 and CG-761 middle management assisted. CG-633 and OSC were not informed. This was motivated not only by loss of confidence in MASI, but also heavily influenced by E30 and continued CG-9333/CG-741 reluctance to implement MASI solutions, or to define interconnection requirements. They created the concept of a "simple scheduler" which would run natively under WK (solving

E30), with minimal automated functionality. Many WK IOP actions would be performed manually by IOC personnel to satisfy high-level congressional requirements. CG-9333 planned for the perennially resource constrained developers at C3CEN to implement the "Simple Scheduler" (although C3CEN would no longer be required to interact with MASI) illustrating a reciprocal effect where continued neglect of MASI caused additional work for WK. C3CEN at the developer level is not believed to have been initially aware of this because they were later forced to create a "level of effort" for the undertaking.

- Event Type: Implicit
- Implicit Category: Control
- Severity: 6
- Impact: Time/Scope: An increase in C3CEN WK time (est. 3-4 months) and change to scope, in an attempt to remove dependence on MASI
- Occurrence Time Frame:

36. E36: MASI 2.0 Demonstration to Senior Stakeholders/Funding Pitch

- Description: The OSC MASI team and OSC leadership believed MASI development would be canceled. The MASI technical lead and the author presented a MASI functional demonstration at HQ to several key stakeholders, including O-6s from CG-741, CG-9333, CG-761, CG-633, and OSC in an effort to save the program. The demonstration focused on the extensive MASI 2.0 functionality already completed at that time. All attendees were impressed (The CG-761 directorate head labelled the result "visionary," and "the future of the CG"), but unfortunately no source of MASI funding for 2012 was identified. CG-741 verified that even if MASI funding were found, the MASI team would not develop the "simple scheduler" as defined, but would revert to prior MASI 2.0 requirements, which were still incomplete. The remaining motivation for MASI development was enterprise CG use beyond the DOG.
- Event Type: Implicit
- Implicit Category: Funding Priority
- Severity: 7
- Impact: None beyond support of CG-761. An attempt to demonstrate the value of MASI development to date, and the potential presented by the system

- Occurrence Time Frame: January 2012

37. E37: RDML CG-7 Memo: MASI No Longer to Provide Any Functionality for WK

- Description: This official memo allowed WK to develop the "Simple Scheduler" and voided MASI as the system to complete WK IOP requirements. The RDML noted insufficient funds, lack of requirements, and loss of WK segment 2 as factors (a combination of E6. and WK downgrade).
- Event Type: Explicit
- Implicit Category: n/a
- Severity: 8
- Impact: Cost/Time: CG-9333 wasted an estimated $4M-$5M by eliminating MASI from eventual use in WK, and added 3-4 months of development effort to C3CEN WK for the Simple Scheduler
- Occurrence Time Frame: January 2012

38. E38: CG-761 Provides $200k Interim MASI Funding

- Description: Extensive budget meetings were held with the C4IT-SC in an attempt to identify MASI 2012 funding. A full year commitment was not forthcoming but CG-761 pledged to send an FTA of $200k to OSC to keep the development team in place until the end of February. At that time a final funding decision was to be made. Even at that point, in the face of all opposition, the CG-761 directorate head believed the program would continue. He stated:

I am tired of discussing getting an RP for MASI. I expect the C4ISR RC to use our working capital fund to develop MASI and eliminate AOPS/TMT and ALMIS/EAL. This is not a secret. I expect all to follow my direction AND EXECUTE THE DIRECTION. (Personal communication, January 25, 2012)

Despite this directive, CG-761 middle management continued to undercut MASI and recommend cessation of development.

- Event Type: Implicit
- Implicit Category: Funding Priority
- Severity: 3
- Impact: Cost: $200k
- Occurrence Time Frame: January 2012

39. **E39: Loss of 55 Percent of MASI Team Over Four Months, Including Technical Lead and Senior Developer**

- Description: Morale on the OSC MASI development team had continued to degrade due to the compounding events involving CG-9333, WK, and HQ middle management. The contagion had reached a critical point. The message was continually delivered, directly and indirectly, that MASI was not worthy of prioritization. From October 2011, to February 2012, 55 percent of the OSC MASI development team resigned. Loss of the team technical leader was the final blow from which development could not recover on any practical timeline. At this time the author recommended cessation of development and maintenance of MASI 1.1 for DOG use (which continues to the date of this writing).
- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 8
- Impact: Time: Undefined delay, minimum 5 months, to allow rebuilding and training of new OSC MASI team (was not attempted)
- Occurrence Time Frame: October 2011-February 2012

40. **E40: Course of Action (COA) EOC Meeting**

- Description: The official meeting where MASI development was indefinitely halted. Operations and maintenance funding was used to sustain MASI 1.1 operation for the CG DOG users.
- Event Type: Implicit
- Implicit Category: Capacity
- Severity: 10
- Impact: Cost: As noted in E3, ~$6.5M+$470k (MRTO). MASI 1.1 development was a modest ~$650k and was the only version released for use (CG DOG)
- Occurrence Time Frame: February 2012

APPENDIX B. MASI 1.1 TO 2.0 ARCHITECTURAL CHANGES

MASI 1.1 Architecture

MASI 1.1 consists of a single user interface that bridges data from two back-end information systems. The user interface is built in Silverlight 3.0. It communicates via traditional SOAP communications to a WCF data service (web service). The data service coordinates calls to two SQL Server persistent data stores (MASI and MISLE) to fulfill data requirements.

All users of MASI 1.1 are members of the Coast Guard Active Directory deployment. User authentication is handled via traditional authentication methodologies in a single-sign on scenario (Kerberos and NTLM). In addition, all users are accessing the application via the CGDN only. No DMZ access is currently available.

To facilitate MASI 1.1 capabilities, we addressed the following key components:

1. Users and the security model for the application.
2. Coast Guard hierarchy.
3. Coast Guard Resources.
4. Appointments.

Users and the security model for the application

In 1.1, MASI has strict relationships with user account management processes in MISLE. The model is based on explicit approvals for a user-to-Coast-Guard-unit inside the MISLE database. Direct calls from MASI to MISLE are utilized to validate what units a given user has authority to access when the user logs into the MASI application.

Coast Guard Unit Hierarchy

MASI 1.1 uses data stored in MISLE to generate a hierarchical representation of units. Data used includes the MISLE unit table coupled with the AOPS unit reference data which contains a recursive relationship to drive parent-child hierarchy.

Coast Guard Resources

MASI 1.1 uses data stored in MISLE to generate resource listings for each unit. These resources include AOPS and ALMIS reference data representing resources from those systems, in addition to MISLE local resource data.

Appointments

The data pertaining to the scheduling of resources (units and physical assets) is housed in the MASI data store.

MASI 2.0 Scope & Architecture

Some of the MASI 2.0 requirements drove goals like decoupling from MISLE, obtaining information directly from systems of records, addressing port partner capabilities (including existing user identity stores), expansion of the application presence to a new security domain (DMZ), and publishing of data after modifications to other systems. MASI 2.0 was a fundamental architectural redesign.

Architectural goals included utilizing the Coast Guard's Enterprise Service Bus to obtain the information necessary to fulfill system requirements by establishing data feeds from the Coast Guard IT systems designated as "systems of record." Also, due to the introduction of a new security zone (DMZ) and users from a disparate identity store, a solution had to be addressed to facilitate user authentication and authorization. This solution also came into play when accessing data inside the Coast Guard Data Network. Some of the data presented back to the client needed to be filtered, masked, or in some cases, not even sent back to the consuming user interfaces.

To facilitate MASI 2.0 capabilities, we addressed the following key components:

1. Identify solution for user authentication/authorization in multiple security zones.
2. Identify data sources necessary to fulfill decoupling (hierarchy & resources).
   a. Establish tools for ESB/SOA interaction
   b. Establish data feeds with necessary systems of record.
3. Identify solution for the data tier to support data masking, filtering, or omission based on user permissions.
4. Implement new requirements for port partner capabilities.
   a. Account management
   b. Ability to create/manage port partner organizations & resources.
   c. Integration with Coast Guard capabilities.
5. Implement solution to support transmission of data after modification.

User Authentication/Authorization

Our immediate goals focused on addressing an interoperable solution for solving user authentication/authorization in a solution based on multiple security domains. To address this, we externalized these capabilities to a security token service and built in application trusts to these capabilities. Authentication and authorization data was passed using industry standard xml-based SAML tokens.

These tokens allow for interoperability between C3CEN WatchKeeper capabilities, Juniper device, MASI user interface, and MASI data services.

Establish tools for ESB/SOA interaction

Tooling was developed to work with the Coast Guard ESB to facilitate the sending and receiving of data necessary to fulfill decoupling from MISLE.

Establish data feeds with necessary systems of record

Extensive work has been performed from the PSOA, MISLE, MASI, ALMIS, and AOPS teams to fulfill MASI 2.0 data requirements.

Identify solution for the data tier to support data masking, filtering, or omission based on user permissions

MASI 2.0 data services have been re-engineered to take advantage of the WS-* specification. Utilizing WS-Federation, we are able to apply logic decisions on data calls that can impact what data is returned to the clients.

Implement new requirements for port partner capabilities

Additions were made to SQL Server to facilitate requirements additions to support port partner capabilities. The data services were extended to support a hierarchy of Coast Guard departments and port partner organizations.

Author, William Saunders, MASI Team Technical Development Lead

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APPENDIX C. MASI TEAM OF THE QUARTER AWARD (MASI 1.1)

The Operational Systems Center's (OSC) Mission and Asset Scheduling Interface Team is cited for superior performance and outstanding teamwork during this period, specifically the successful development and release of a major system upgrade.

MASI is a web enabled tool to support operational planning and current asset status, providing a means to capture planned and executed operations for USCG and port partners as required by the Security and Accountability for Every (SAFE) Port Act.

Timely requirements definition and superlative work by the development team, while adhering to a very tight schedule, enabled the successful release of a major update to the MASI system. The system update incorporates extensive new functionality and performance enhancements: redundant data transfer was reduced by 73 percent, data payload size by 65 percent, and the returned payload was compressed by 33 percent. The release enabled CG use of MASI 5 months sooner than the originally projected solution and allowed termination of the non-enterprise MHS-OPS program. Quality of design and ease of use allowed quick adoption of the tool by the entire CG Deployable Operations Group (DOG) and 27 subunits, as well as facilitating area and district users. To date, DOG users have created over 1400 Missions. The PACAREA Chief of Response (PAC-33) conveyed his satisfaction and lauded MASI as a "great success story of collaboration." In the same release, the team also completed development work on a Tasked Asset data service for IOC WatchKeeper to support maritime awareness for the USCG, DHS and DOD Port Partners. Close coordination between C3CEN and the team enabled the data service delivery 5 weeks before required date.

Also during this period, extensive work was completed on the next major release which will enable direct nationwide port partner access and participation

in the MASI IOC/WatchKeeper scheduling process. The team bridged gaps between HQ program sponsors, CG-9333 and fellow Centers of Excellence (COEs) while identifying 75 new Functional Requirements for a 163 percent increase in IOC Interagency Operational Planning (IOP) requirements. New functionality included replacement of the security model, a binary attachment service, and implementation of claims based modeling. Superior teamwork was demonstrated in collaboration with Emerging Technologies (ET) in the establishment of a baseline .NET enterprise ESB client and security token service capabilities as an enterprise solution for authentication and authorization. Subsequent release will promote interagency asset utilization and mission coordination, projected to save millions of dollars each year.

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